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PHYSIOLOGIC FACTORS IN DIFFERENTIAL DIAGNOSIS OF PARALYSIS OF SUPERIOR RECTUS AND SUPERIOR OBLIQUE MUSCLES

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AN ARTICLE by Davis [1] on the differential diagnosis of paralysis of a superior oblique muscle and paralysis of the opposite superior rectus muscle has revived the argument between Bielschowsky and Duane as to the relative frequency of these paralyses, the former believing that most vertical anomalies are due to paralysis of the superior oblique, while the latter credited the superior rectus with the majority. Davis found the superior oblique paretic in 54.5 per cent of 88 cases of vertical anomalies and the superior rectus in 45.4 per cent. White and Brown [2] had previously reported that only 4 per cent of cases of vertical anomalies were due to paralysis of the superior oblique and that 96 per cent were due to paralysis of the superior rectus. Smith [3] recently pointed out the serious discrepancy between these two sets of figures and pleaded for a more uniform standardization of methods of diagnosis.

Such a discrepancy in figures must be due to the employment of different criteria in diagnosing paralysis of a vertically acting muscle or to differences in the type of case analyzed by different authors. The classic signs of paralysis of each of these muscles should enable one to make a positive diagnosis unless factors not generally recognized arise and make the diagnosis difficult. In the usual textbook picture the following signs are so characteristic that one should be able to make a positive differential diagnosis when they are present:

1. The head is tilted. This is the most characteristic sign of paralysis of a superior oblique muscle, and, although it occurs to a lesser degree with paralysis of a superior rectus muscle, it is pronounced only with

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1. Davis, W. T.: Paresis of Right Superior Oblique and of Left Superior Rectus Muscle, Arch. Ophth. **32**:372-380 (Nov.) 1944.

2. White, J. W., and Brown, H. W.: Occurrence of Vertical Anomalies Associated with Convergent and Divergent Anomalies, Arch. Ophth. **21**:999-1009 (June) 1939.

3. Smith, J. W.: Paresis of Right Superior Oblique and of Left Superior Rectus Muscle, Arch. Ophth. **33**:77 (Jan.) 1945.

paralysis of one of the oblique muscles. The reason for this may be stated as follows:

When the eyes are in the primary position, a paralysis of one of the oblique muscles produces a marked tilting of the vertical meridian of the affected eye and little up or down displacement. Figure 1 shows that the superior oblique muscle is 100 per cent effective in depressing the globe only when the eye is adducted 51 degrees. Since the effectiveness of a muscle in producing any particular movement of the globe changes from zero to 100 per cent through a rotation of 90 degrees, each degree represents an increase in effectiveness of 1.1 per cent from the

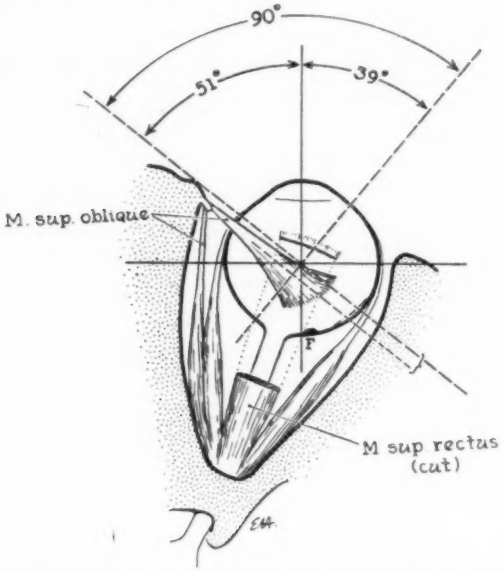

Fig. 1.—Effectiveness of the superior oblique muscle in depressing the globe when the eye is adducted 51 degrees.

zero position. In the primary position, the effectiveness of the superior oblique muscle as a depressor is 42.9 per cent, and its effectiveness as an intorter is 56.1 per cent.

When these figures are compared with those for the superior rectus (fig. 2), it is evident that in the primary position this muscle is 73.7 per cent effective as an elevator and only 25.3 per cent effective as an intorter. What has been said of these two muscles is equally true of the inferior oblique and inferior rectus muscles.

The response on the part of the body to a paralyzed ocular muscle is to compensate as far as possible for the disturbing effects of the diplopia produced. This can be accomplished either by suppressing the image of one eye or by holding the head in such a position that the diplopia is

abolished or lessened. The position of the head, which is the present concern, is determined by the action the paretic muscle has in the primary position of gaze.

In the case of paralysis of an internal rectus or an external rectus muscle the head is simply turned toward one or the other shoulder, since these muscles have no action other than horizontal rotation. The superior and inferior rectus muscles and the oblique muscles, however,

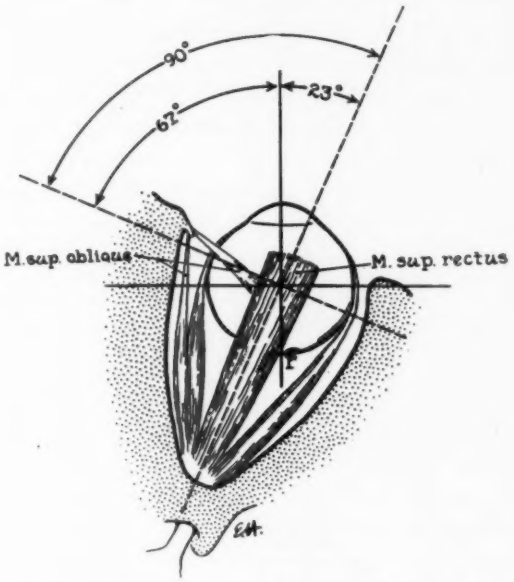

Fig. 2.—Effectiveness of the superior rectus muscle as an elevator and as a depressor.

Effectiveness of Rectus and Oblique Muscles in Primary Position

Muscle	Intorsion or Extorsion, %	Elevation or Depression, %
Superior rectus	25.3	73.7
Inferior rectus		
Superior oblique	56.1	42.9
Inferior oblique		

have both vertical action and torsion in the primary position of gaze by the amounts just estimated (table). The head must be moved, therefore, in such a manner as to compensate as far as possible for both these components. (I have purposely left out the abducting and adducting actions of these muscles because they do not seem to me to be theoretically correct as usually given. The superior rectus, for example, is called an adductor, which is true in the primary position. As the eye is turned

nasalward, the adducting power should increase; but as it is turned temporally and beyond 23 degrees the action should change to abduction. Besides this, the lateral phorias may so alter the final picture in the horizontal, when the eyes become dissociated, that it would only confuse the issue to take this action into account here.)

The vertical component can be compensated by elevating or depressing the chin. The torsional component must be taken care of by tilting the head on one or the other shoulder. It was first shown by Nagel in 1871[4] that when the head is tilted on the shoulder the vertical meridians of the corneas remain vertical and do not tip as the head tilts. It is now well known that the muscles controlling torsion are under the influence of tonic impulses from the otolith apparatus and that when the head is tilted on one shoulder the vertical meridian of the eye on that side is intorted to keep it vertical and the vertical meridian of the opposite eye is extorted to keep it vertical. If the head is tilted on the right shoulder, for example, the muscles which intort the right eye (superior rectus and superior oblique) contract, and the muscles which extort the vertical meridian of the left eye (inferior rectus and inferior oblique) contract. In this way the vertical meridians are kept upright.

If a muscle which produces torsion in the primary position is paralyzed, the vertical meridian of that eye will be tilted and will not be parallel to the vertical meridian of the opposite eye. In order to avoid this tilt, as well as the vertical deviation which occurs (if the superior oblique is paralyzed, the eye will be extorted and higher than the opposite eye, owing to the unopposed tone of the inferior oblique and the compensating pull of the superior rectus of the same side), the head will be be held in that position which brings the vertical meridian of the normal eye parallel with that of the paralyzed eye. This is accomplished by tilting the head on the opposite shoulder. In this position the intorters of the sound eye and the extorters of the paralyzed eye are contracted. The intorters of the paralyzed eye are relaxed; hence, in a paralysis of the superior oblique muscle the vertical meridians are brought into parallelism by tilting the head on the opposite shoulder, and the up and down deviation is kept at a minimum.

Tilting of the head is therefore marked and is diagnostic of paralysis of an oblique muscle. It does occur with paralysis of a superior rectus muscle, but to much less extent.

2. The head is always tilted to the side opposite the paralyzed muscle. For example, in a case of right hypertropia due to paralysis either of the right superior oblique or the left superior rectus, if the right superior

4. Nagel, A.: Ueber das Vorkommen von wahren Rollungen des Auges um die Gesichtslinie, Arch. f. Ophth. **17** (pt. 1):237, 1871.

oblique is at fault, the head will be strongly tilted toward the left shoulder; if the left superior rectus is at fault, the head will be slightly tilted toward the right shoulder.

3. A third means of differentiation, which is to be found in cases of both recent and old paralysis of an oblique muscle, but is never present with paralysis of the vertical rectus muscles, is the vertical movement of an eye with a paralyzed oblique muscle when the head is tilted by the examiner on the shoulder of the same side as the paralyzed eye. If the right superior oblique is paralyzed and the head is tilted on the right shoulder, the right eye will be seen to make a definite upward movement. Bielschowsky [5] called attention to this sign, and he and Davis stressed the subjective phenomena which accompany it, i. e., the increase in the vertical diplopia. Since the majority of patients with vertical motor paralysis are children, who frequently suppress with one eye, diplopia fields often cannot be taken, and the objective sign is therefore of much more value.

The pathologic physiology which produces this vertical movement is as follows: Tilting the head on the right shoulder sends an increase of tonic impulses to those muscles of the right eye which cause intorsion, i. e., the right superior oblique and the right superior rectus. Normally these two muscles, contracting together by just the right amount, produce nothing but intorsion, as their elevating and depressing actions on the globe neutralize one another. If the right superior oblique is paralyzed, the superior rectus works alone and produces some intorsion but also a marked elevation of the globe, since its upward movement is no longer prevented by the forward pull of the superior oblique muscles.

If the superior rectus is paralyzed and the head tilted on the shoulder of the same side, no upward movement of the globe is produced, since the muscle which is most effective in producing intorsion is still intact (superior oblique). The necessary amount of intorsion is produced by this muscle practically alone, the superior rectus being contracted simultaneously merely to counterbalance the slight depressing action of the superior oblique as it contracts in the primary position. If any vertical movement of the globe results from this tilting procedure it will be a slight downward movement of the eye, due to the unopposed action of the superior oblique.

On the basis of these facts, one should be able to differentiate between a paralysis of the superior oblique and a paralysis of the superior rectus of the opposite side by the following criteria:

1. One eye will be higher than the other when the eyes are in the primary position, i. e., there will be right or left hypertropia. If the

5. Bielschowsky, A.: Lectures on Motor Anomalies, Hanover, N. H., Dartmouth College Publications, 1940.

paralysis is of the superior oblique muscle, it will be on the side of the higher eye. If the paralysis is of the superior rectus muscle, it will be on the side of the lower eye.

2. If the patient habitually carries the head tilted on the shoulder of the side of the higher eye, the muscle paralyzed will be the superior rectus of the opposite eye. The tilting of the head will probably not be pronounced. If the head is habitually tilted on the shoulder of the side of the lower eye, the paralyzed muscle is the opposite superior oblique. The tilting of the head will generally be pronounced.

3. If the examiner, having decided which eye has the paralyzed muscle, tilts the patient's head to the shoulder of the same side as the paralyzed eye, this eye will be seen to make an upward movement if the superior oblique is paralyzed but will not move upward if the superior rectus is paralyzed. If any vertical movement occurs, it will be a slight downward movement.

These diagnostic signs hold only for unilateral paralyses. They are of no value in cases of bilateral paralyses. They are diagnostic in cases of primary vertical motor paralyses, usually congenital; but there is doubt as to their value in cases of so-called secondary vertical motor paralyses, i. e., those cases of convergent squint associated with an incomitant vertical deviation. The type of paralysis I have in mind is generally reported as a convergent squint associated with an overaction of one or both inferior oblique muscles. It seems probable that the explanation of the discrepancy between Davis' statistics and those of White and Brown is that the latter authors were basing their opinion of the frequency of paralyses of the superior rectus on statistics of cases of the latter type, whereas Davis had in mind the isolated primary vertical motor paralysis. In my experience, an isolated primary vertical motor paralysis is most commonly due to paralysis of the superior oblique, and isolated paralyses of the superior rectus are rare and nearly always associated with ptosis. On the other hand, the vast majority of the cases of secondary vertical motor paralyses more nearly fit into the picture of paralysis of a superior rectus. In all such cases in which I have applied the diagnostic tests just outlined the paralysis acts more like one of the superior rectus. In these cases the tilt of the head is never marked; nor does either eye move upward when the head is tilted by the examiner on either shoulder. In this respect I agree with White and Brown, but it seems to me the evidence is still too scant to justify a positive assertion that there is or has been a paralysis of the superior rectus in theses cases. The nature of the paralysis is still far from clear.

One frequently sees statements in the literature that when a muscle is paralyzed its antagonist overacts and then undergoes contracture or shortening. Chavasse [6] made the following statements, for example:

> If the external rectus becomes paretic the internus eventually becomes shortened. It overacts . . . if the left superior oblique is paretic there follows contracture and overaction of the inferior oblique (direct antagonist). This may persist . . . even if the original palsy is no longer clinically demonstrable.

Contracture of a muscle does occur in cases of severe paralysis if the condition is of long standing, but the use of the term "overaction" should not be used here but should be limited to what is true overaction of a yoke muscle. When an external rectus muscle is paralyzed, the eye may become convergent in the primary position, owing to the normal tone of the internal rectus, which eventually leads to a shortening or contracture of this muscle. This muscle is not overacting. The same thing is true of the inferior oblique in cases of paralysis of the superior oblique. When a superior oblique is paretic, the inferior oblique is not opposed by its normal tone; and so the eye may be elevated, owing to contracture of this muscle. This is quite different from the true overaction of the inferior oblique when the superior rectus of the opposite eye is paretic and both eyes are turned up and to the side of the paretic superior rectus. This overaction is due to the well known law of Hering that all willed ocular movements are brought about by an equal innervation to the muscles of the two sides. If one side is abnormally weaker than the other, the amount of nervous energy which will be sent equally to the two sides is that which is just sufficient to complete the movement in the weaker of the two sides. Hence, when there is paresis of a muscle, an excessive amount of innervation must be sent to it, and, accordingly, the yoke muscle will receive an excess innervation and will therefore overact. The inferior oblique may move the eye too far as the eye is adducted because of (1) lack of opposing tone of its paretic antagonist, i. e., the superior oblique of the same side, and (2) overaction due to paralysis of its yoke muscle on the opposite side, i. e., the opposite superior rectus.

Another factor may so camouflage a paralysis of the superior oblique that it resembles a paralysis of the superior rectus of the opposite side. This is the phenomenon known as inhibitional palsy of the contralateral antagonist. So far as I know, Chavasse first called attention to this, and he alone has cautioned against mistaking it for paralysis of a superior rectus muscle.

In cases of paralysis of the superior oblique in which there is tilting of the head the patient may choose to fix either with the higher (para-

6. Chavasse, F. B.: Worth's Squint or the Binocular Reflexes and the Treatment of Strabismus, ed 7, Philadelphia, P. Blakiston's Son & Co., 1939.

lyzed) eye or with the lower (sound) eye. According to Chavasse, if the patient habitually fixes with the sound eye, inhibitional palsy will never occur, but if he habitually fixes with the paralyzed eye then the sound eye will show a limitation of movement when looking up and to the sound side. If there is a paralysis of the right superior oblique, for example, and the patient habitually fixes with this eye, then on his looking up and to the left the left eye will not move up as far as normally. This will simulate a paralysis of the left superior rectus muscle.

The physiologic basis of this phenomenon is probably as follows: The patient is fixing with his paralyzed right eye. The right inferior oblique is not opposed by a normal tone from the paretic right superior oblique. Therefore, less nervous impulse is needed to elevate the eye in levoversion than is normally required. The yoke muscle of the right inferior oblique, i. e., the left superior rectus, gets less than the required amount of stimulation, which therefore prevents the left eye from moving up as far as the right eye; in other words, an underaction of the superior rectus exists by virtue of understimulation, just as overaction of a yoke muscle may be due to overstimulation.

The importance of this feature in a case of paralysis of a superior oblique muscle is evident. The following case of paralysis of the left superior oblique was first diagnosed as one of paresis of the right superior rectus muscle, before it was recognized that the underaction of the latter was due to inhibitional palsy.

CASE 1.—*Diagnosis: Primary paralysis of left superior oblique; inhibitional palsy right superior rectus.*

J. Y., a boy aged 11, was admitted July 20, 1943, with a history of tilting the head to the right shoulder since early childhood. The motility of the neck was free, and there was no evidence of any motor weakness or contracture of the muscles of the neck.

Visual acuity with the best correction was 6/20 in the right eye and 6/6 in the left eye. There was considerable anisometropia, the right eye having a hypermetropia of 2.50 D., while that of the left eye was corrected with a +0.37 D. cylinder, axis 35.

Fixation was carried out with the left eye, the right eye being deviated downward, and the right eye failed to move much above the midline on the patient's looking up and to the right. A tentative diagnosis of ocular torticollis due to paralysis of the right superior rectus muscle was made.

At first, diplopia fields showed no double vision in any direction of gaze, but this was due to the fact that the child constantly suppressed the image of the right eye. Later, diplopia fields showed a vertical diplopia, with the lower image corresponding to the left eye. The greatest separation of the images occurred on looking down and to the left. Ophthalmoscopic examination revealed no pathologic condition, and form and color fields were normal.

On the synoptophore, his objective measurements were as follows: esotropia, 4 degrees; left hypertropia, 13 degrees. There were rapidly alternating fixation

and momentary fusion at the objective angle. No fusion occurred at zero. The patient tended to suppress with the right eye but showed alternating fixation when stimulation was given.

Screen and parallax tests showed that the greatest separation of the visual axes occurred on looking down and to the left. In this position the right eye

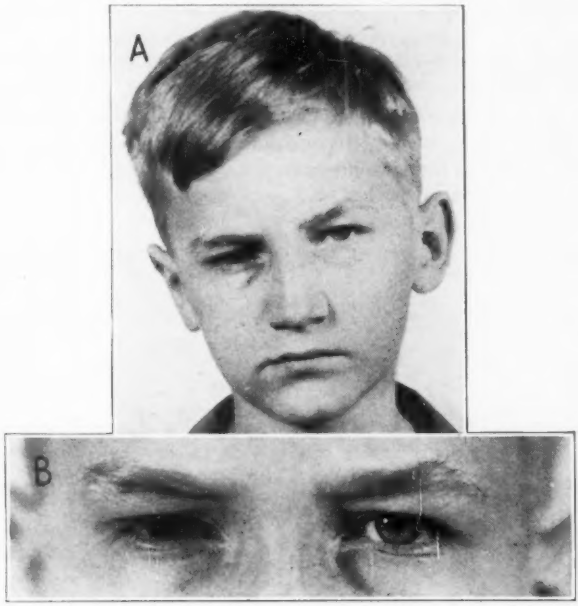

Fig. 3.—*A*, photograph of patient showing the head tilted to the right shoulder and fixation carried out with the left eye, which is the higher. *B*, closer view, showing the left hypertropia and fixation with the left eye. The picture was taken with the patient looking directly into the camera, i. e., at the reader's one eye.

Fig. 4.—*A*, no deviation of the visual axes on looking up and to the left. *B*, no deviation on looking down and to the left. *C*, greatest deviation of the visual axes on looking down and to the right. The right eye moves down fully, while the left eye fails to do so. *D*, patient looking up and to the right, showing how the right eye fails to go up completely, owing to inhibitional palsy, while the left eye moves up completely.

moved down fully, while the left eye failed to follow down. In addition, however, there was a pronounced lag of the right eye on looking up and to the right, as already mentioned, so that in this position also the left eye was the higher.

Two diagnoses were possible: (1) paralysis of the right superior rectus, which could account for the failure of the right eye to move up and to the right, and (2) paralysis of the left superior oblique. The latter seemed likely in view of the failure of the left eye to move down when the gaze was directed down and to the right.

A final diagnosis of paralysis of the left superior oblique muscle was made on the following evidence, as outlined in the paper:

1. There was a decided tilt of the head to the patient's right shoulder. This is in keeping with paralysis of the left superior oblique. If the right superior rectus had been paralyzed, the head would have been tilted to the left shoulder, and the tilt would not have been so marked.

2. The patient habitually fixed with the paralyzed eye, i. e., the left, as the right eye was partially amblyopic. On his looking to the right and up, therefore,

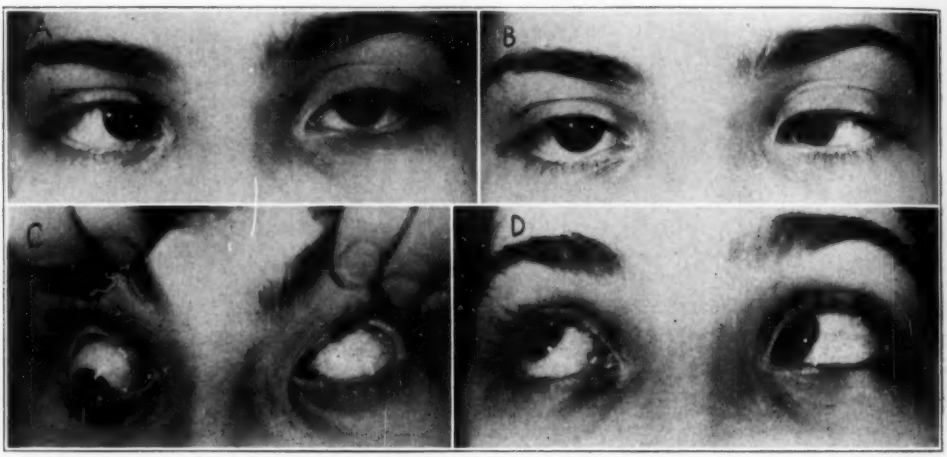

Fig. 5.—*A*, no vertical deviation when the patient is fixing with the left eye. *B*, depression of the left eye 8 degrees when the patient is fixing with the right eye (paretic inferior rectus muscle). *C*, greatest vertical deviation when the patient is looking down and to the right. The right eye fails to move down normally (palsy of the right inferior rectus), and the left eye moves down too far (overaction of the left superior oblique). *D*, patient looking to the right and up. The left eye fails to move up as far as the right owing to inhibitional palsy of the left inferior oblique muscle.

the left inferior oblique muscle had no opposition from the paralyzed left superior oblique and required less than the normal amount of innervation to accomplish its purpose. This lack of innervation to the muscles which turn both eyes up and to the right resulted in insufficient innervation of the right superior rectus to carry this eye up. The result was apparent paralysis of the right superior rectus.

CASE 2.—*Diagnosis: Alternating convergent squint with secondary paralysis of right inferior rectus muscle and inhibitional palsy of left inferior oblique.*

D. P., a girl aged 15, was admitted on March 6, 1945 with a history of having had a convergent squint as long as could be remembered. Visual acuity was equal

in the two eyes with correction of a moderate amount of hyperopia and was normal.

The convergent alternating squint measured 25 degrees at 6 meters without correction and was slightly less with glasses. When the patient was fixing with the right eye, the left eye turned down about 8 degrees in the primary position. The downward deviation of the left eye was greatest on looking down to the right. Although the right eye could be moved down and to the right, rotation of the right eye in this direction was not quite so complete as the corresponding movement of the left eye down and to the left. A tentative diagnosis of paresis of the right inferior rectus with partial recovery was made. This had resulted in an overaction of the left superior oblique muscle when the eyes were turned down and to the right.

When the patient was fixing with the right eye, the left eye lagged behind on looking up and to the right, indicating weakness of the left inferior oblique muscle. It was decided that this was an inhibitional palsy, and not a true paralysis, on the

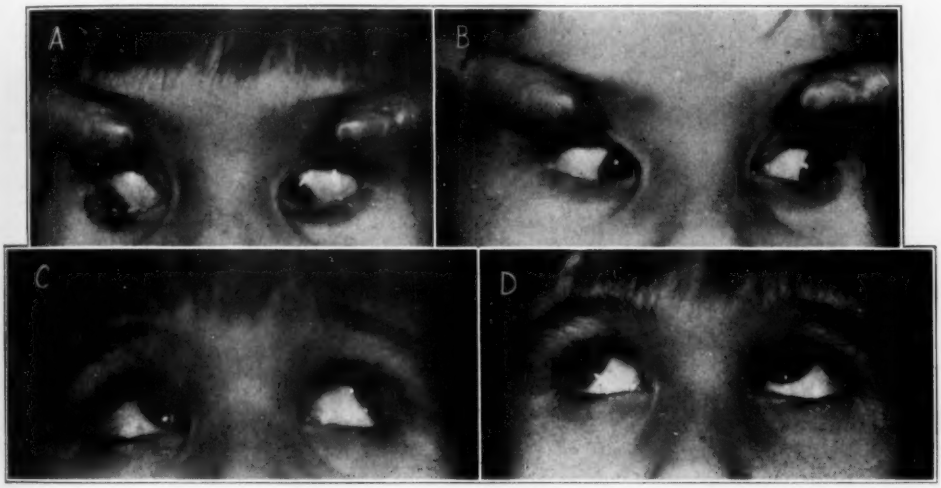

Fig. 6.—*A*, patient looking down and to the right. The left eye fails to move down completely. *B*, patient looking down and to the left. The eyes move equally well. *C*, patient looking up and to the left. The eyes move equally well. *D*, patient looking up and to the right. The right eye fails to move up completely.

basis of the following reasoning: The right inferior rectus muscle was paretic, so that its normal tone was absent. The right superior rectus muscle, therefore, needed less than the usual innervation to turn this eye up and to the right. Less than the normal amount of innervation was sent to the corresponding yoke muscle, the left inferior oblique, on turning both eyes up and to the right. This simulated a paralysis of the left inferior oblique. Head tilt was not present, and no upward movement of the right eye occurred when the head was tilted on the right shoulder.

Case 3.—*Diagnosis: Primary, congenital paralysis of left superior oblique and inhibitional palsy of right superior rectus.*

E. H., a girl aged 4, had been treated in the orthopedic department for torticollis from the age of 6 months. Surgical treatment was considered, but the idea was abandoned in favor of massage and diathermy. The mother brought the child

to the ophthalmic department on May 24, 1945 because she noted a peculiarity in the position of the eyes.

Examination showed that the head was habitually tilted to the right shoulder 15 degrees (measurement of the orthopedic department). The left eye was higher than the right, and the greatest vertical deviation of the eyes occurred when she looked down and to the right. There was no vertical difference between the eyes when the child looked down and to the left.

When the patient fixed with the left eye, the right eye lagged behind on looking up and to the right, owing to inhibitional palsy of the right superior rectus muscle. When the head was forcibly tilted to the left shoulder, the left eye could be seen to make an upward movement.

Visual acuity was 6/9 in each eye without correction. The patient habitually fixed with the left eye. The findings on the synoptophore were as follows: Objective measurement of the deviation in the primary position was 4 degrees of left hypertropia. Superposition and fusion were present at the objective angle. Diplopia occurred when the hypertropia was not corrected on the instrument, and there was no trace of suppression.

Fig. 7.—Head forcibly tilted on the left shoulder. The left eye moves up.

All these findings fit in well with the diagnosis of congenital paralysis of the left superior oblique muscle.

SUMMARY

In cases of primary or congenital paralysis of a vertically acting muscle a differential diagnosis between paralysis of the superior oblique of one side and the superior rectus of the opposite side may be made on the basis of the following signs:

1. The head is tilted. This is the most characteristic sign of paralysis of the superior oblique muscle. It is due to the fact that con-

traction of this muscle in the primary position results in 56 per cent of the movement being intorsion. Paralysis of the muscle results, therefore, in extorsion, which can be compensated only by tilting the head in a position which brings the two vertical meridians into parallelism again, i. e., tilting the head on the opposite shoulder. Tilting the head occurs with paralysis of the superior rectus, but is slight, since the superior rectus in the primary position produces only 25 per cent of its pull as intorsion.

2. The head is always tilted toward the side opposite the paralyzed eye. Hence, in a given case of right hypertropia due to paralysis of either the right superior oblique or the left superior rectus muscle, the head will be strongly tilted toward the left shoulder if the right superior oblique is paralyzed and slightly tilted toward the right shoulder if the left superior rectus is at fault.

3. If the head is tilted by the examiner on the shoulder of the same side as the paralyzed eye, this eye will make an upward movement if the superior oblique is paralyzed. If the superior rectus is paralyzed, the eye either will not move at all or will move slightly downward. The physiologic basis for this is given.

Most primary or congenital vertical motor paralyses are due to paralysis of the superior oblique muscle. Those secondary vertical motor paralyses which are associated with a convergent squint and in which the vertical component is seen only in the adducted eye are not due to paralysis of the superior oblique, but may be due to paralysis of the superior rectus—at least they behave more like paralysis of this muscle.

A factor which may confuse the picture in primary or secondary paralysis of a vertically acting muscle is the occurrence of inhibitional palsy of the contralateral antagonist. When this is present, primary paralysis of the superior oblique may easily be mistaken for paralysis of the superior rectus. A physiologic explanation of the phenomenon is given, and illustrative cases are reported.

313 South Seventeenth Street.

PRODUCTION OF CATARACTS IN CHICKS WITH DINITROPHENOL

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SAN FRANCISCO

THE OCCURRENCE of cataract following the ingestion of dinitrophenol was first reported in 1935.[1] Within the next six years 177 cases had been published in the literature.[2]

Thorough experimentation on laboratory animals prior to the release of dinitrophenol for medical use was carried out by Tainter and his fellow workers at Stanford University School of Medicine. Further careful work was done following the report of cataracts due to dinitrophenol in man. In no instance was it possible to produce cataracts in the ordinary laboratory animals,[3] nor was it possible to produce experimental cataracts by feeding dinitrophenol to animals deficient in vitamins A, B or C.[4] The incidence of cataracts could not be increased when dinitrophenol was administered in conjunction with such cataract-producing agents as lactose and galactose.[5] The animals used in all instances were mammals.

Until recently it was assumed that cataracts did not develop in these laboratory animals because of some difference in their metabolism and that of the human species. In 1944 Robbins [6] reported the development of cataracts in young chicks and ducks, and the present preliminary report confirms Robbins' work.

This study was supported by a grant from Mrs. Francis I. Proctor.

From the Division of Ophthalmology, Stanford University School of Medicine.

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6. Robbins, B. H.: Dinitrophenol Cataract: Production in an Experimental Animal, J. Pharmacol. & Exper. Therap. **80**:264 (March) 1944.

Four 3½ week old white leghorn pullets were placed on a diet containing 0.25 per cent 2:4 dinitrophenol. Microscopic examination with the slit lamp had previously revealed that the lenses of each chick were entirely clear. Within seven hours after the chicks had been placed on the diet containing dinitrophenol definite lenticular opacities were noted in each eye of all the chicks. The opacities were limited to the anterior and posterior subcapsular regions. The posterior subcapsular area was more densely opaque than the anterior, and in each instance the opacity was denser in the axial portion of the anterior and posterior subcapsular layers and tended to clear toward the periphery. The nucleus and the remainder of the lens cortices remained entirely clear, nor were any other abnormalities noted on microscopic examination with the slit lamp.

Twenty-six hours after the chicks had been placed on the dinitrophenol diet, and approximately seventeen hours after the cataracts described were observed, examination with the slit lamp revealed a marked decrease in the opacification of the lens in spite of continued administration of dinitrophenol in the same concentration. In 2 of the chicks the anterior subcapsular opacities had cleared entirely, and the posterior subcapsular opacities had decreased but were still definitely present. Again, the remaining opacity was denser near the axial portion. In the other chicks the clearing was less dramatic, but definite.

Three and one-half days after the dinitrophenol diet was started, 3 of the chicks had died. Examination of the remaining chick with the slit lamp picture showed that the picture was unchanged: A very fine anterior subcapsular opacity and a somewhat denser posterior subcapsular opacity remained. The remainder of the lenses was clear at all times. The death of these chicks was almost certainly due to the concentrated dose of dinitrophenol, since Tainter [3a] has shown this action of the drug in shortening the life span of white rats. The administration of dinitrophenol was discontinued at this point.

My observations on the experimental cataract in chicks produced by dinitrophenol differed from those of Robbins [6] in that the opacities in the posterior subcapsular area also regressed, although to a somewhat lesser degree than those in the anterior. Robbins reported that the posterior opacities persisted or increased, but his description did not include the findings with slit lamp microscopy. It is of interest to note that the refractile play of colors, the "cloth of gold" appearance, so frequently seen in human cataracts after the ingestion of dinitrophenol was not observed.

This rapid appearance and subsequent regression of cataracts have not been observed in animals other than fowl. Six white mice were placed on a diet containing 0.25 per cent 2:4 dinitrophenol and examined microscopically with the slit lamp at the same time intervals as the

chicks, and no changes in the lens were noted. Six congenitally obese yellow mice [7] were also placed on the same diet and examined at the same time intervals, and no lenticular changes were found. The congenitally obese yellow mice were selected because they show some predisposition to the formation of cataract after ingestion of dinitrophenol.[8]

The interesting observation of Robbins, substantially confirmed here, poses a number of questions. Are the rapidly forming and somewhat transient lenticular opacities which are observed in fowl, and in no other animals, connected in some manner with the increased metabolism and higher temperature of avians? Why do the opacities clear while the dinitrophenol is still being administered? These and other interesting questions will be investigated.

SUMMARY

In spite of numerous cataracts observed after the ingestion of dinitrophenol in human subjects, it had not been possible to produce cataract in mammals by the use of this drug, although Robbins accomplished this in young chicks and ducks.

Additional observations on the formation of cataracts in chicks on a diet of dinitrophenol are reported here. The cataracts were limited to the anterior and posterior subcapsular regions and were more marked in the latter. The cataracts were well formed seven hours after the start of the dinitrophenol diet and regressed to a great degree while the drug was still being administered. In white and in congenitally obese yellow mice cataracts failed to develop under the same conditions.

2351 Clay Street (15).

7. Danforth, C. H.: Hereditary Adiposity in Mice, J. Hered. **18**:153, 1927. Rytand, D. A.: Hereditary Obesity of Yellow Mice, Proc. Soc. Exper. Biol. & Med. **54**: 340, 1943.

8. Bettman, J. W.: Experimental Dinitrophenol Cataract, Am. J. Ophth., to be published.

USE OF NEUTRALIZING ANTIBODY TEST IN DIAGNOSIS OF HUMAN TOXOPLASMIC CHOROIDITIS

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THE publication by Sabin [1] of the neutralizing antibody test for the diagnosis of toxoplasmosis encouraged us to utilize this laboratory method in cases of suspected toxoplasmic choroiditis. It was our early ambition to make clinical observations in a few cases, in which laboratory tests had proved that the lesions of choroiditis were undoubtedly positive or negative for Toxoplasma, and with this experience to be able to make a presumptive diagnosis of the disease, without necessity of finding a coexisting cerebral calcification or a positive reaction to the neutralizing antibody test to confirm the diagnosis. Such observations during the past three years prompt us to state that until a more accurate or a more convenient means is devised, the neutralizing antibody test must be used if a relatively certain diagnosis is to be made.

Callahan's [2] estimate that the incidence of toxoplasmosis in the St. Louis population is about 2 per cent emphasizes to ophthalmologists the importance of this infectious granuloma, whose only observable manifestation may be a destructive central choroiditis.

METHODS AND MATERIAL

The neutralizing antibody test for Toxoplasma was performed (after Sabin) as follows:

The Organism.—Both the Sabin [3] R. H. strain, isolated from the brain tissue of a 6 year old boy who died of encephalitis, and the strain of Wolf, Cowen and

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1. Sabin, A. B.: Toxoplasma Neutralizing Antibodies in Human Beings and Morbid Conditions Associated with It, Proc. Soc. Exper. Biol. & Med. **51**:6-10 (Oct.) 1942.

2. Callahan, W. P., Jr.: The Incidence of Toxoplasmic Infection in the St. Louis Area, in Annual Report of the John and Mary R. Markle Foundation, New York, 1944, p. 29.

3. Sabin, A. B.: Toxoplasmic Encephalitis in Children, J. A. M. A. **116**: 801-807 (March 1) 1941.

Paige,[4] isolated from the spinal cord of an infant who died of encephalomyelitis at 31 days of age, were used in this laboratory. The organism remains viable only by culture in living tissue; murine passage proves the most expedient. The mice are inoculated intracerebrally with 0.03 cc. of a 1 : 10 suspension of infected tissue, and they die at intervals of four to eight days. The virulence of the organism is enhanced by decreasing the intervals between passage. The brains are removed with sterile technic, and sufficient Tyrode's solution is added to make a 1 : 5 dilution by weight. From this tissue suspension a smear is made, stained and examined for the presence of toxoplasmas. To check for contamination, one tube of aerobic and one tube of anaerobic medium are inoculated and incubated for twenty-four hours. In the refrigerator the uncontaminated Toxoplasma suspension will thus be kept viable for ten days, but we have found that to maintain virulence it is advisable to reinoculate within two days.

The Neutralizing Antibody Test.—Five to 10 cc. of blood is taken by venipuncture from the patient for use within twenty-four hours. If tests are not made immediately, the labile antibody of the serum is protected by lyophilization or by freezing at —77 C. (A known positive serum allowed to stand at room temperature for three hours before centrifugation gave a negative test.) Serums are used undiluted. After the brains are found to be uncontaminated, they are ground with sterile sea sand abrasive, and four times the amount by weight of Tyrode's solution is added and allowed to settle spontaneously for thirty minutes. The supernate, considered to be a 1 : 5 suspension, is removed into another sterile tube, and subsequent dilutions of 1 : 10, 1 : 50, 1 : 500 and 1 : 5,000 are made from it. Suitable aliquots of these dilutions are added to equal amounts of Tyrode's solution to make the control mixtures. Similar aliquots are also added to equal amounts of each serum to be tested. The mixtures are shaken gently and allowed to stand thirty minutes, and 0.2 cc. is injected intracutaneously with a tuberculin syringe in areas marked on the back of a shaved, clear-skinned rabbit. An appropriate chart is made of the sites of inoculation, and daily checks are made for color and size of the lesion, for size of the necrotic portion and, as the lesions progress, for presence or absence of hemorrhage.

The lesions on the rabbit are papulonecrotic, reaching a maximum about the seventh day after the inoculation and blanching thereafter until the rabbit dies, usually within ten or twelve days. Death is preceded by high fever and increasing weakness.

Evaluation of Results.—The papular lesions are measured in millimeters for the largest diameter and the widest possible measurement at right angles to it. The diameters of necrosis within the papule are measured in the same way. The area of each lesion is then calculated, using the formula for an ellipse, unless the lesion is circular. By comparative use of the planimeter on tracings of the same lesions, we found estimated measurements of area to be generally within 15 per cent of the actual. Calculations of area for the smallest lesions, which were 2 to 3 mm. at their widest diameter, were in error 18 to 33 per cent. For a patient's serum to be considered positive, the area of the serum lesions must be one-half or less that of the corresponding control lesions.

4. Wolf, A.; Cowen, D., and Paige, B. H.: Human Toxoplasmosis: Occurrence in Infants as an Encephalomyelitis; Verification by Transmission to Animals, Science **89**:226-227 (March 10) 1939.

OBSERVATIONS

The patients under consideration were, for the most part, a selected group, with central chorioretinitis, active or inactive, and a clear vitreous.

TABLE 1.—*Statistical Summary of Reactions of Serums Tested for Toxoplasma Neutralizing Antibodies*

	Number Tested	Reactions			
		Number		Per Cent	
		Positive	Negative	Plus	Minus
Patients with chorioretinitis without cerebral calcification	28	16	12	57	43
Patients with chorioretinitis and with cerebral calcification	4	4	0	100	0
Patients without chorioretinitis					
Mothers of toxoplasmic patients	2	2	0	100	0
Sibs german of toxoplasmic patients	10	8	2	80	20

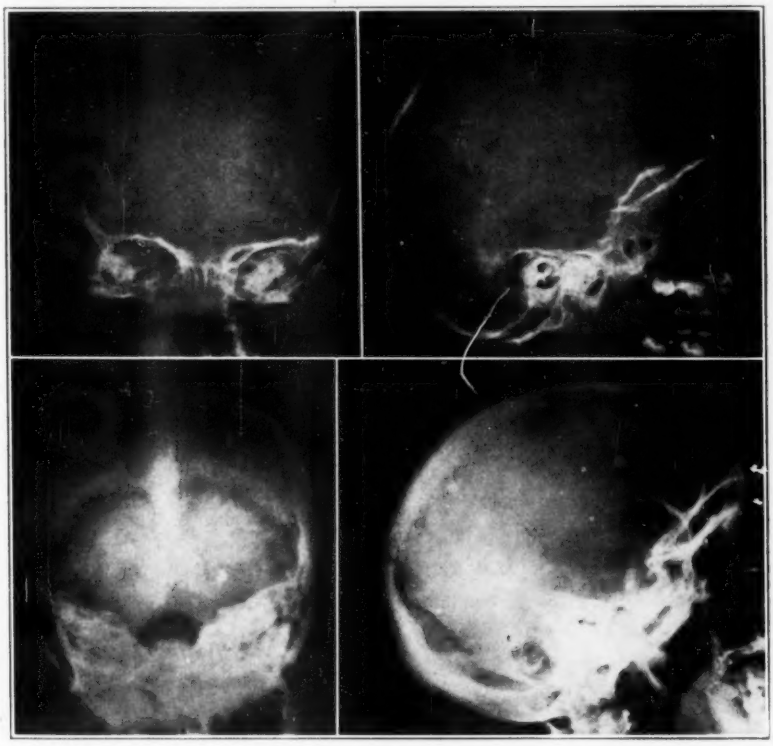

Fig. 1.—Roentgenograms (anteroposterior and lateral) showing cerebral calcification in 2 patients who had neutralizing antibodies for Toxoplasma in the serum.

Among the serums of 32 patients having such chorioretinitis, 20 had neutralizing antibodies (table 1). Four of the 20 had cerebral calcification in addition (fig. 1). It is to be emphasized that we have not

seen cerebral calcification with chorioretinitis in persons whose age at onset could be proved to be over 15 years.

A survey of cases of probable congenital toxoplasmosis from the literature and from this laboratory (table 2) showed that of 45 patients with choroiditis and a positive reaction to the Toxoplasma neutralizing

TABLE 2.—*Summary of Cases of Toxoplasmic Chorioretinitis, First Observed in Childhood, and Probably a Congenital Infection*

Author	Patient	Age at Examination	Reaction to Neutralization Test	Cerebral Calcification
Wolf, A., and Cowen, D.: Bull. Neurol. Inst. New York 6 : 306-371 (July) 1937	J. S.	2 days	*	+
Wolf, A.; Cowen, D., and Paige, B. H.: Am. J. Path. 15 : 657-694 (Nov.) 1939	C. D.	3 days	*	+
Paige, B. H.; Cowen, D., and Wolf, A.: Am. J. Dis. Child. 63 : 474-514 (March) 1942	L. M.	Birth	*	+
Levin, P. M., and Moore, H.: J. Pediat. 21 : 673-679 (Nov.) 1942	G. F. H.	3½ mo.	†	+
Sabin, A. B.: Toxoplasmosis, a Recently Recognized Disease of Human Beings, in De Sanctis, A. G.: Advances in Pediatrics, New York, Interscience Publishers, Inc., 1942	R. B.	6 mo. (?)	+	+
Crothers, B.: Arch. Neurol. & Psychiat. 49 : 315-319 (Feb.) 1943	1	12 yr.	+	+
	4	‡	+	+
	5	‡	+	+
	6	‡	+	+
	7	‡	+	+
	9	10 yr. 7 mo.	+	+
	9	4 yr. 9 mo.	+	+
Koch, F. L. P.; Wolf, A.; Cowen, D., and Paige, B. H.: Arch. Ophth. 29 : 1-25 (Jan.) 1943	P. D.	1 wk. (?)	+	+
	J. F.	Birth	+	+
	A. I.	4 days	+	+
	M. B.	2 mo.	+	+
	D. H.	4 yr. (?)	+	+
	C. J.	3 mo.	+	—
Vail, D.; Strong, J. C., Jr., and Stephenson, W. V.: Am. J. Ophth. 26 : 133-140 (Feb.) 1943	N. H.	7 yr.	+	—
	J. S.	12 yr.	+	—
	C. S.	7 yr.	+	+
	C. C.	7 yr.	+	+
	F. W.	Birth (?)	+	—
Steiner, C., and Kaump, D. H.: J. Neuropath. & Exper. Neurol. 3 : 36-48 (Jan.) 1944	‡	1 day	*	+
Wagener, H. P.: Am. J. M. Sc. 208 : 255-264 (Aug.) 1944	‡	Infant	+	+
Zuelzer, W. W.: Arch. Path. 38 : 1-19 (July) 1944	H.	1 mo.	*	+
Heath, P., and Zuelzer, W. W.: Arch. Ophth. 33 : 184-191 (June) 1945	L. H.	2 mo.	+	+
Heidelman, J. H.: Arch. Ophth. 34 : 28-39 (July) 1945	R. S.	6 mo.	+	+
	R. B.	7 yr.	+	+
	N. T.	11 mo.	+	+
	L. H.	1 mo.	+	+
	B. J.	9 mo.	+	—
	L. H.	7 yr.	+	‡
	J. O.	13 yr.	+	—
	S. J.	8 yr.	+	—
	T. W.	16 yr.	+	—
	L. S.	22 yr.	+	—
	A. S.	15 yr.	+	—
Authors' cases	M. G.	3 yr.	+	+
	S. H.	3½ yr.	+	+
	Mrs. S.	5 yr.	+	+
	J. W.	3 yr.	+	+

* Toxoplasmas found in the tissue.
† Positive reaction to complement fixation test for Toxoplasma.
‡ Age not mentioned.

antibody test, only 7 did not also have cerebral calcification. When the age at onset was over 15 years (table 3), there was no instance of cerebral calcification. The mother of Crother's sixth patient and our own Mrs. G. were the only mothers of a child with toxoplasmosis who had cerebral calcification in addition to neutralizing antibodies in the serum (table 4). Twenty-two other mothers who presumably transmitted the infection in utero had only positive reactions to the neutralizing antibody test, with no other symptoms. Sabin,[1] in a summary, noted that of 15 children with toxoplasmosis, 13 had mothers with neutralizing antibodies in the serum; 1 other child gave positive reaction to a complement fixation test for toxoplasmosis as did his

TABLE 3.—*Summary of Cases of Toxoplasmic Chorioretinitis, First Observed After Childhood and Probably an Acquired Infection*

Author	Patient	Age at Examination, Yr.	Reaction to Neutralization Test	Cerebral Calcification
Vail, D.; Strong, J. C., Jr., and Stephenson, W. V.: Am. J. Ophth. **26**: 133-140 (Feb.) 1943				
	H. G.	23	+	—
	W. W.	29	+	—
	E. C.	17	+	—
Authors' cases	Mrs. Q. S.	23	+	—
	Mrs. H.	26	+	—
	M. D.	15	+	—
	E. G.	36	+	—
	M. P.	33	+	—
	G. H.	26	+	—
	G. E.	35	+	—
	I. K.	25	+	—
	K. P.	36	+	—
	G. H.	36	+	—
	J. P.	19	+	—
	E. B.	15	+	—
	C. R.	50	+	..
	E. D.	16	+	—
	J. L.	29	+	—

mother. Of 13 paternal serums described in the literature (including 4 not indicated in table 4), only 1, reported by Sabin, gave a positive reaction. Sixteen of 24 sibs-german also gave positive reactions to the test. Thus in the families of 45 patients with toxoplasmosis, 56 other members showed positive antibody titers for Toxoplasma; only 15 gave negative reactions.

Little is known concerning congenital toxoplasmosis contracted from an infected mother.

Mrs. G., aged 41, and her 10 children presented an unusual opportunity to study the familial incidence of neutralizing antibodies. First born was M. G., two months prematurely; the child had bilateral choroiditis, nystagmus, mental retardation and cerebral calcification, probably present from birth. Mrs. G., M. G. and the next 5 children in the family all had strongly positive reactions to the neutralizing antibody test for toxoplasmosis; the youngest 4 children gave negative, positive, negative and positive reactions, in that order. The mother

TABLE 4.—*Familial Relationships in Cases of Toxoplasmosis*

Author	Initial	Patient: Chorioretinitis	Patient: Neutralizing Test	Patient: Cerebral Calcification	Mother: Neutralizing Test	Mother: Cerebral Calcification	Father: Neutralizing Test	Father: Cerebral Calcification	Sib 1: Neutralizing Test	Sib 1: Cerebral Calcification	Sib 2: Neutralizing Test	Sib 2: Cerebral Calcification	Sib 3: Neutralizing Test	Sib 3: Cerebral Calcification	Sib 4: Neutralizing Test	Sib 4: Cerebral Calcification	Sib 5: Neutralizing Test	Sib 5: Cerebral Calcification
Paige, B. H.; Cowen, D., and Wolf, A.: Am. J. Dis. Child. **63**: 474-514 (March) 1942	L. M.	+	*	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	B. R.	+	*	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Levin, P. M., and Moore, H.: J. Pediat. **21**: 673-679 (Nov.) 1942	G. F. H.	+	†	+	+	—	—	—	..	..	..	..	..	..	..	..	..	..
Crothers, B.: Arch. Neurol. & Psychiat. **49**: 315-319 (Feb.) 1943	1	+	+	+	+	..	—	..	±	..	±	..	..	..	..	..	..	..
	2	—	+	+	+	..	—	..	+	..	+	..	..	..	..	..	..	..
	4	+	+	+	+	..	..	..	+	..	+	+‡	—	..	—	..	..	..
	6	+	+	+	+	+	..	..	+	+	+	+‡	..	..	..	..	..	..
	8	+	+	+	+	—	..	—	..	—	..	..	..	..	..	..	..	..
Koch, F. L. P.; Wolf, A.; Cowen, D., and Paige, B. H.: Arch. Ophth. **29**: 1-25 (Jan.) 1943	P. D.	+	+	+	—	..	—	..	..	..	..	..	..	..	..	..	..	..
	J. F.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	A. I.	+	+	+	—	..	..	..	..	..	..	..	..	..	..	..	..	..
	M. B.	+	+	+	—	..	..	..	..	..	..	..	..	..	..	..	..	..
	D. H.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Vail, D.; Strong, J. C., Jr., and Stephenson, W. V.: Am. J. Ophth. **26**: 133-140 (Feb.) 1943	N. H.	+	+	—	+	..	—	..	—	..	—	..	..	..	..	..	..	..
	J. S.	+	+	—	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	C. S.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	C. C.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Zuelzer, W. W.: Arch. Path. **38**: 1-19 (July) 1944. Heath, P., and Zuelzer, W. W.: Arch. Ophth. **33**: 164-191 (June) 1945	L. H. §	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	H.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Heidelman, J. H.: Arch. Ophth. **34**: 28-39 (July) 1945	R. S.	+	+	+	+	..	—	..	..	..	..	..	..	..	..	..	..	..
	R. B.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	N. T.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	L. H.	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	B. H.	+	+	—	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	D. M.	+	+	—	—	..	±	..	..	..	..	..	..	..	..	..	..	..
	B. J.	+	+	—	+	..	..	..	..	..	..	..	..	..	..	..	..	..
	S. J.	+	+	—	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Authors' cases	M. G.	+	+	+	+	+	..	..	+	—	+	—	+	—	+	—	+	—§
	S. H.	+	+	+	+	..	..	..	+	—	..	..	..	..	..	..	..	..

* Toxoplasmas were seen in the tissues.
† This patient gave a positive reaction to a complement fixation test for toxoplasmosis.
‡ These sibs-german (cases 5 and 7, respectively) had also chorioretinitis, and the condition was diagnosed as toxoplasmosis.
§ Sibs 6, 7, 8 and 9 gave negative, positive, negative and positive reactions, respectively.

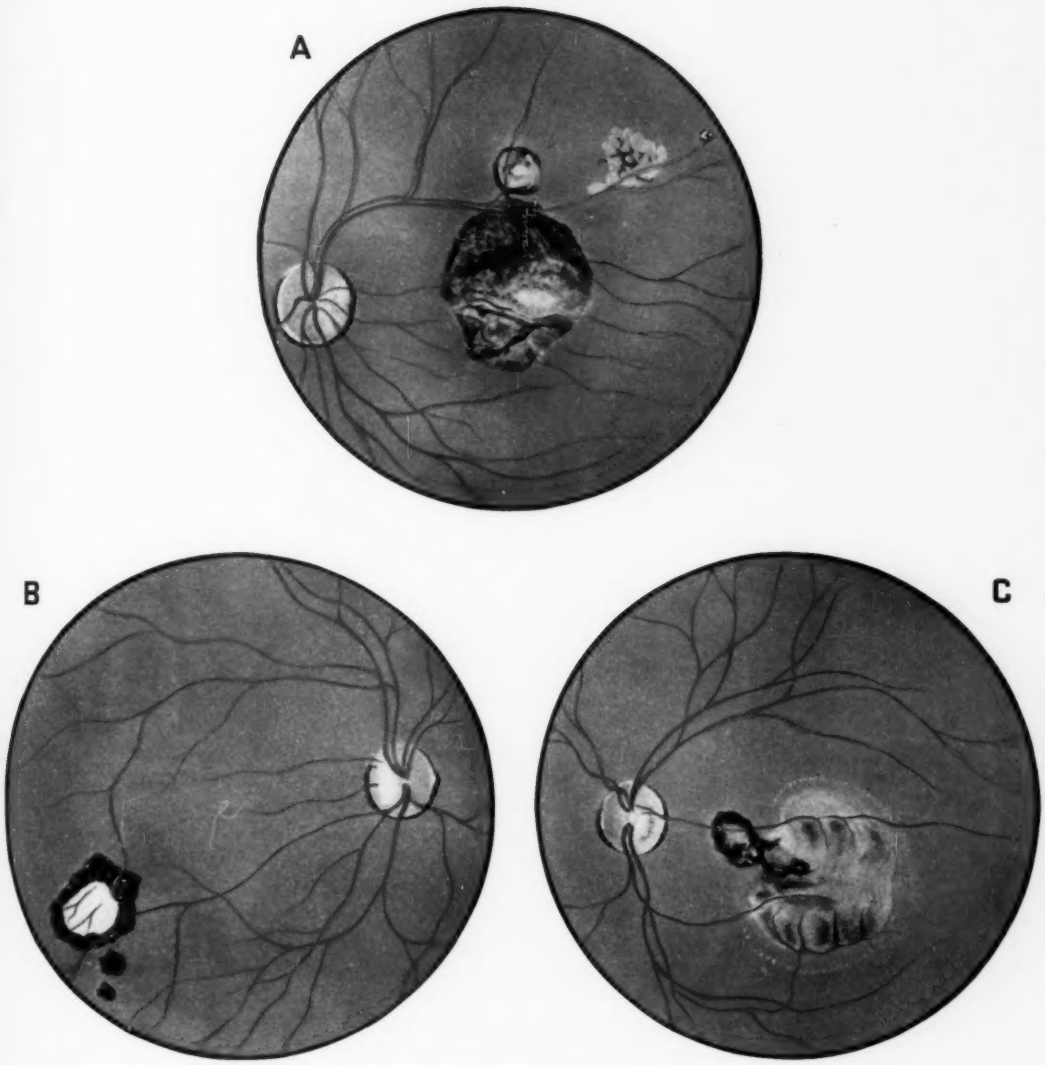

Fig. 2.—*A* (Mrs. S.), monocular congenital chorioretinitis after thirty-five years of inactivity. *B* (Mrs. Q. S.), healed chorioretinitis of the right eye, which developed during the second pregancy. *C*, acquired central chorioretinitis (left eye of Mrs. Q. S.), showing the deeply pigmented area remaining from activity of the first pregnancy and the much larger, slightly active, lesion which developed during the second pregnancy. Fundus drawings by Theodora Bergsland.

had typical toxoplasmic calcification of the cerebrum, without chorioretinitis. None of the children except M. G. had chorioretinitis or gave roentgenographic evidence of calcification of the cerebrum.

Mrs. H. had neither chorioretinitis nor calcification of the cerebrum but did have a high titer of neutralizing antibodies. First born was S. H., who had bilateral choroiditis, mental retardation and calcification of the cerebrum. S. H. was first examined roentgenographically in 1944, at the age of 3½ years. By comparison, the roentgenograms taken in 1945 showed markedly denser calcification of the original areas with no increase in the number of centers of calcification. The second child was M. H., who gave a strongly positive reaction to the neutralizing antibody test but had normal fundi, alert mentality and no cerebral calcification. There were no other children. During the third month of the pregnancy with S. H. a pet puppy "became blind and had fits and diarrhea," and this may have been the source of the maternal infection.

Mrs. S., who gave a positive reaction to the neutralizing antibody test for Toxoplasma, had monocular chorioretinitis (fig. 2 *A*), probably congenital, which was first observed before the age of 4 years. Roentgenograms also showed calcification of the cerebrum. Her daughter, 3 years old, appeared normal on roentgenographic and funduscopic examinations and did not have neutralizing antibodies. In this case it would seem that no infection or immunity was transmitted to the third generation.

Mrs. Q. S., aged 22, had central choroiditis early in the second month of her first pregnancy and was anxious to receive any benefits from killed typhoid bacilli regardless of possible consequences to the fetus. After a mild febrile reaction to the second injection of typhoid vaccine she miscarried, and the fetus was not saved. The choroiditis slowly subsided. A year later, when she was again gravid, the primary lesion in the left eye again became active, extending within a month to about twice the original size (fig. 2 *B*). There also appeared in the right eye a lesion about 2 disk diameters below the macula (fig. 2 *C*). This did not progress toward the macula, although no treatment was given. At this time facilities were available for performing the neutralizing antibody test, to which she gave a positive reaction. At term she was delivered of a normal baby, whom we have not yet been able to test for the presence of neutralizing antibodies. Post partum, the choroiditis in the right eye promptly became inactive, and the larger lesion in the left eye gradually subsided. Nine months ago her third pregnancy was accompanied with moderately severe activity in the damaged (left) eye. A thorough course of sulfadiazine was given, without observable effect on the lesion, and her request for a therapeutic abortion was granted as an aid in preserving the central vision in her right eye. No pathologic changes were present in the fetus. After this third pregnancy there was no activity in the lesion in the right eye, and the lesion in the left eye became clinically inactive in the three months after the uterus was emptied. It seems likely that this case is one of the form of toxoplasmosis in which activation of pseudocysts accompanies pregnancy. It may be that Mrs. Q. S. produced sufficient antibodies to protect the fetus from infection but some change associated with pregnancy, possibly chemohormonal, caused a clinically quiescent pseudocyst to become an active chorioretinal lesion. In agreement with the findings of Weinman,[5] our experiments on chronic toxoplasmosis showed that rabbits which have recovered from one

5. Weinman, D.: Chronic Toxoplasmosis, J. Infect. Dis. **73**:85-92 (July-Aug.) 1943; Human Toxoplasma, Puerto Rico J. Pub. Health & Trop. Med. **20**: 125-161 (Dec.) 1944.

inoculation of toxoplasmas carry the organism as pseudocysts in vulnerable tissue for a long time, without symptoms of active infection. Such pseudocysts can then become actively pathogenic by subinoculation of the infected tissue into mice.

Two of 4 laboratory workers who gave negative reactions to the test when they started working with the organism have since given positive responses. Neither of them showed calcification or other clinical evidence of toxoplasmosis. One of them has had a baby which is normal in all respects. A serum from a patient with sympathetic ophthalmia and a serum sent by Dr. Theodore Terry, of Boston, from a patient with retinitis exudativa (Coat's disease) showed no neutralizing antibodies for Toxoplasma.

SUMMARY

The procedure for the neutralizing antibody test for Toxoplasma and a method for its evaluation are described.

Thirty-two selected patients with chorioretinitis were tested; 20 of these gave positive reactions to the neutralizing antibody test.

Cerebral calcification in patients who had toxoplasmosis with chorioretinitis was not observed when the age at onset was known to be over 15 years. If the disease was present at birth, calcification was evident.

A mother with reactivated toxoplasmic choroiditis and a woman who was probably congenitally infected each gave birth to a normal child. Two children probably infected congenitally with toxoplasmosis had younger siblings-german with antibody protection but no demonstrable infection.

A case of chronic toxoplasmosis is described in which a quiescent chorioretinal lesion became activated during each of three pregnancies.

Major A. B. Sabin, formerly of the Children's Hospital of Cincinnati, and Dr. A. Wolf, of Columbia University College of Physicians and Surgeons, provided the strains of Toxoplasma used.

EFFECT OF QUALITY OF ILLUMINATION ON THE RESULTS OF THE ISHIHARA TEST

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THIS is the third in a series of reports dealing with the Ishihara test for color blindness. In the first of these reports [1] the fifth edition of the test was evaluated as a means of detecting and analyzing defective color vision. The data reported were collected during the course of a study of 106 persons having defective color vision of varying types and amounts, including 74 who had definite defects in color vision and 32 who had low, but normal, color vision. To study these persons a comprehensive battery of color tests [2] was used, some of which are well known in the field of color blindness testing and some less well known; some have been devised in this laboratory. The fifth edition of the Ishihara test, one of the best known of the shorter editions, was selected for inclusion in the battery of tests. The results obtained from the entire battery aided in the classification of the defect in color vision as to type and extent and at the same time permitted us to evaluate each test of the battery both as a diagnostic or screening medium (the purpose of which is to screen out the subjects with defective color vision from those with normal color vision) and as a medium for classification (the purpose of which is to determine the type and extent of the defect).

Concerning the fifth edition of the Ishihara test, it was concluded that when properly administered the test affords a good rough device for screening persons with defective red-green vision from persons with normal color vision if a performance score of 60 is taken as the critical score, that is, if 60 per cent of the plates are read correctly. In the group tested, no subject with defective color vision scored more than 58 and no subject with normal color vision scored less than 75.

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1. Hardy, L. H.; Rand, G., and Rittler, M. C.: Tests for the Detection and Analysis of Color-Blindness: I. An Evaluation of the Ishihara Test, Arch. Ophth. **34**:295-302 (Oct.) 1945.

2. Hardy, Rand and Rittler,[1] p. 297.

The Ishihara test is, however, only a gross test for defective red-green vision. It fails to classify the type of defective color vision (protanopia, protanomaly, deuteranopia, deuteranomaly, tritanopia, tritanomaly [3]) and cannot be used to give a satisfactory evaluation of the extent of the defect, no matter how carefully administered.

In the second of these reports [4] a comparative evaluation was made of three representative editions of the Ishihara test (the fifth,[5] the seventh [6] and the British reprint of the ninth [7]) and of the Ishihara plates included in the American Optical Company's compilation of pseudoisochromatic plates.[8] Twenty-two subjects to whom the entire battery of tests had been administered were available for that work. The general conclusion drawn was that on the whole the three editions of the Ishihara test yield the same type of results in spite of the changes that have been made in the number of plates and in the plates themselves, some of which are improved in one edition as compared with the others while other plates are less effective. The seventh and ninth editions have been improved over the fifth edition so far as detection of protanomalous and protanopic subjects is concerned; but the plates used for the classification of type of red-green defective vision are less successful for deuteranomalous and protanomalous subjects, particularly as reproduced in the seventh edition. None of the editions yields a differential score as to the extent of defective color vision. It seems probable from the data that the critical performance score of 60, marking the dividing line between low normal and defective color vision, holds for the seventh and ninth editions of the test. This critical score, it will be remembered, was established for the fifth edition on the larger group of subjects, which included both observers with defective color vision and those with low normal color vision. The Ishihara plates appearing in the American Optical Company's test

3. For a simple explanation of these terms, see Hardy, Rand and Rittler,[1] page 298, footnote 14. Additional references are: Hardy, L. H., and Rand, G.: Recent Developments in Color Vision Testing, Graduate Course, American Academy of Ophthalmology, Outlines of Instructional Courses, Continuous Course nos. 6 and 7, 1944. Hardy, L. H.; Rand, G., and Rittler, M. C.: Color Vision and Recent Developments in Color Vision Testing, Arch. Ophth. **35**:603-614 (June) 1946. Judd, D. B.: Facts of Color-Blindness, J. Optic. Soc. America **33**:294-307 (June) 1943.

4. Hardy, L. H.; Rand, G., and Rittler, M. C.: Tests for Detection and Analysis of Color Blindness: II. Comparison of Editions of the Ishihara Test, Arch. Ophth. **35**:109-119 (Feb.) 1946.

5. Ishihara, S.: Tests for Colour-Blindness, ed. 5., Tokyo, Kanehara, 1925.

6. Ishihara,[5] ed. 7, 1936.

7. Ishihara, S.: The Series of Plates Designed as Tests for Colour-Blindness, reprinted from ed. 9, London, H. K. Lewis & Co., Ltd., 1943.

8. Pseudo-Isochromatic Plates for Testing Color Perception, Philadelphia, American Optical Company, 1940.

were found, however, to be for the most part poor selections and poor reproductions of the original Japanese plates and to have less value for screening deuteranomalous and deuteranopic subjects than the plates as reproduced by Ishihara.

The present report describes the effect produced on the results of the Ishihara test by changing the quality of the illumination under which the test is administered. A comparison was made between the two most commonly used illuminants: daylight, for which the tests were designed, and tungsten filament light, which is far too frequently used because of carelessness or lack of proper facilities, combined with ignorance of the important effect of quality of illumination on the results of all tests which employ test material seen by reflected light.

The critical importance of quality of illumination for all tests of this type, particularly for the polychromatic and pseudoisochromatic plates which are being used for the detection of defective color vision, was stressed in the first report of this series,[1] also independently by Hardy.[8a] Because of their great convenience and apparent simplicity of administration, plates of this type have been widely employed in military and industrial fields for many years. We expressed the belief that part of the dissatisfaction that has been reported with regard to the findings with these tests has been due to disregard of the critical importance of the illumination under which the tests were administered. As already indicated, tests of this type were designed to be administered under daylight, and instructions to that effect are given. Too often, however, they have been carelessly administered under artificial light, usually tungsten filament light. The composition of this light, as compared with average daylight, is relatively strong in the long wavelength portion of the spectrum and weak in the short wavelength portion. Consequently, when tungsten light is employed instead of daylight, there will be enhancement of red and yellow pigments, dulling of green and blue pigments and a shift in hue of the mixed colors toward the long wavelengths.

To determine the effect of this incorrect administration, subjects with defective color vision were tested with different editions of the Ishihara test, utilizing the same amounts (25 foot candles) of different illuminants. The responses were compared when the illuminant was changed from artificial daylight to tungsten filament light. The daylight illumination was obtained from the nearest practical equivalent to ICI Illuminant C, that provided by a Macbeth daylight lamp (tungsten lamp plus filter of Corning Daylight glass) designed to operate at approximately 6,750°K. The tungsten filament illumination was provided by a 75 watt Mazda gas-filled lamp, operating at rated voltage, at a color temperature of approximately 2,848°K. This illumination is equivalent

8a. Hardy, L. H.: Standard Illuminants in Relation to Color-Testing Procedures, Arch. Ophth. **34**:278-282 (Oct.) 1945.

to ICI Illuminant A. For convenience, these illuminations will be called "daylight" and "tungsten" throughout the present report.

The effect of this change in illumination on the results of the test was determined for the fifth, seventh and ninth (British reprint) editions of the Ishihara test and for the Ishihara plates included in the American Optical Company's compilation of pseudoisochromatic plates. Only the plates intended for testing color-blind literates were used, of which there are 12 in the fifth edition, 24 in the seventh and ninth editions and 10 in the American Optical Company's test. These plates consist of six series. Series 1 and 2 are of the "transformation pattern" type, in which the subject with defective color vision sees a different pattern from that which the subject with normal color vision sees; series 3 and 4 are of the "vanishing digit" type, in which the pattern is not seen at all by the subject with defective color vision; series 5 contains a "hidden digit," which is supposedly seen only by a subject with defective color vision, and series 6 is intended for the differential classification of the type of defective red-green vision. A fuller description of the six series of plates is given in the first report of this series.[1] In the fifth edition there are 2 plates of each series; in the seventh and ninth editions, 4 plates of each series, and in the American Optical Company's test, 4 plates of series 1, 4 plates of series 2 and 2 plates of series 5. Differences found in the effect of change of illumination from edition to edition are, of course, due to differences in the pigments used, which in some instances are pronounced.

Twenty-two subjects to whom the entire battery of tests [2] had been administered were available for the present work. They included 12 subjects with anomalous trichromasy, of whom 7 had the deuteranomalous and 5 the protanomalous type, and 10 with dichromasy, of whom 5 were deuteranopic and 5 were protanopic. Differences in the effect of change of illumination found in the subjects with the different types of defective color vision are due both to the extent or degree of the defect and to the characteristic reaction of each type to the color combinations used in the various plates of the Ishihara test.

Throughout the work the testing distance was about 30 inches (76 cm.). Care was taken to avoid any specular reflection from the test plates. To this end, the angle of illumination was approximately 45 degrees and the angle of view 90 degrees.

The general conclusion to be drawn from the study is that performance scores on the Ishihara test tend to be higher for persons with defective red-green vision (i.e., a greater number of correct responses are given) when the illuminant is tungsten light than when it is daylight, most significantly in subjects with deuteranomaly and deuteranopia. The effect is so marked that a substantial proportion of deuteranomalous subjects (42 per cent) score within normal limits

when tungsten light is employed. Further, the Ishihara test is a poorer medium for the differential classification of type of red-green defect when the illuminant is tungsten light. Fewer subjects are correctly classified by the test, more are not classified at all, and a greater number of protanomalous and protanopic subjects are incorrectly classified when the illumination is shifted from daylight to tungsten.

In detail, the results are summarized in tables 1 to 3. They will be discussed under three headings: (1) effect of quality of illumination on responses to the individual plates, (2) effect of quality of illumination on performance scores on the entire test and (3) effect of quality of illumination on the differential classification of deuteranopia and protanopia, deuteranomaly and protanomaly. In each table the results for daylight illumination are given in roman type; those for tungsten illumination in boldface.

EFFECT OF QUALITY OF ILLUMINATION ON RESPONSES TO THE INDIVIDUAL PLATES

Table 1 shows for each type of defective color vision and for each illuminant the percentage of subjects who pass the individual plates of each edition, the plates being designated by both series number and plate number as they appear in the edition under consideration. The first four horizontal rows of figures in roman type under each edition show these percentages for each type of defective color vision when the test is administered under daylight; the first four rows in boldface under each edition show these percentages when the test is administered under tungsten light. These data demonstrate the value of the individual plates for detecting each type of defective color vision when the test is administered under the illuminant indicated. The two bottom rows under each edition show the percentages for the subjects with defective color vision as a group and demonstrate the value of the individual plates for the simple detection of defective color vision.

The following statements summarize the more important changes produced by administering the tests under tungsten illumination instead of daylight:

1. In general a higher percentage of subjects having defective color vision pass the individual plates of the Ishihara test when tungsten illumination instead of daylight is used. This result is most pronounced for deuteranomalous subjects and is particularly evident with the plates as reproduced in the fifth edition. It is next most significant for deuteranopic subjects especially with the Ishihara plates as reproduced in the American Optical Company's selection. In other words, fewer subjects with defective red-green vision, particularly the deuteranomalous and deuteranopic types, are detected by the plates of the

TABLE 1.—*Effect of Quality of Illumination on Responses to the Individual Plates of the Ishihara Test for Each Type of Defective Color Vision.**

Type of Defective Color Vision	Number of Subjects	Quality of Illumination	Percentage of Subjects with each Type Passing Individual Plates																			
			Series 1		Series 2		Series 3			Series 4		Series 5		Series 6								
			Fifth Edition (12 Plates)																			
			Plate No.		Plate No.		Plate No.			Plate No.		Plate No.		Plate No.								
			2	3	4	5	6	7		8	9	10	11	12	13							
Anomalous trichromasy																						
Deuteranomaly	7	Daylight	57	72	0	0	0	14		14	29	14	0	14	29							
		Tungsten	86	72	57	14	72	86		57	72	57	43	43	57							
Protanomaly	5	Daylight	80	100	0	0	0	0		0	0	0	0	20	20							
		Tungsten	80	80	0	0	20	20		20	40	0	0	0	100							
Dichromasy																						
Deuteranopia	5	Daylight	0	0	0	0	0	0		0	0	0	0	0	0							
		Tungsten	0	0	0	0	20	20		0	20	100	20	0	0							
Protanopia	5	Daylight	60	60	0	0	0	0		0	0	20	20	0	0							
		Tungsten	60	20	0	0	0	0		0	0	20	20	20	40							
All types of defective color vision	22	Daylight	50	59	0	0	0	5		5	9	9	5	9	14							
		Tungsten	59	41	18	5	32	36		23	36	45	23	18	50							
			Seventh Edition (24 Plates)																			
			Plate No.				Plate No.					Plate No.				Plate No.				Plate No.			
			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Anomalous trichromasy																										
Deuteranomaly	7	Daylight	43	14	0	14	0	0	0	0	14	14	0	0	29	29	0	0	43	29	14	0	43	57	43	43
		Tungsten	72	29	0	29	72	0	57	43	29	57	0	57	57	43	43	14	57	57	57	57	29	57	86	57
Protanomaly	5	Daylight	0	20	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	40	60	40	20
		Tungsten	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	40	80	20
Dichromasy																										
Deuteranopia	5	Daylight	0	0	20	0	0	0	0	0	0	0	0	0	20	0	0	0	20	0	0	0	0	0	0	0
		Tungsten	0	0	0	0	60	20	20	0	0	0	0	0	40	20	60	40	80	100	100	80	0	0	0	0
Protanopia	5	Daylight	0	20	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	20	20	20	0	0	0	0
		Tungsten	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	40	0	40	0	20
All types of defective color vision	22	Daylight	14	14	5	5	0	0	0	0	5	5	0	0	14	18	0	0	18	14	9	5	23	32	23	18
		Tungsten	23	14	0	9	36	5	23	14	9	18	0	18	27	18	27	14	41	45	45	45	14	36	45	27

Ninth Edition, British Reprint (24 Plates)

			Plate No.				Plate No.				Plate No.				Plate No.				Plate No.				Plate No.			
			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Anomalous trichromasy																										
Deuteranomaly	7	Daylight	43	43	0	14	72	14	57	0	14	29	0	14	14	0	0	0	14	14	0	14	0	57	29	14
		Tungsten	29	43	14	29	100	57	100	0	43	14	0	14	14	14	0	0	29	43	14	43	14	72	29	0
Protanomaly	5	Daylight	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	60	20	20
		Tungsten	0	20	20	0	60	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	20	60	40	20
Dichromasy																										
Deuteranopia	5	Daylight	0	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Tungsten	20	20	0	0	100	60	100	20	0	0	0	0	0	0	0	0	80	80	80	80	0	0	0	0
Protanopia	5	Daylight	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	40	0	20	0	0
		Tungsten	20	20	0	0	20	0	0	0	0	0	0	0	0	0	0	0	20	20	20	40	20	0	20	0
All types of defective color vision	22	Daylight	18	23	0	5	27	5	23	0	5	9	0	5	5	0	0	0	9	9	5	14	5	36	14	9
		Tungsten	18	27	9	9	73	32	64	5	14	5	0	5	5	5	0	0	32	36	27	41	14	36	23	5

Ishihara Plates, American Optical Company's Test (10 Plates)

			Plate No.				Plate No.				Plate No.				Plate No.				Plate No.				Plate No.			
			5	6	11	12	19	20	41	42											33	34				
Anomalous trichromasy																										
Deuteranomaly	7	Daylight	86	43	0	43	72	0	72	57											57	57				
		Tungsten	100	72	29	72	86	86	100	100											29	43				
Protanomaly	5	Daylight	40	0	0	0	0	0	0	0											20	20				
		Tungsten	60	0	0	20	20	0	40	40											20	40				
Dichromasy																										
Deuteranopia	5	Daylight	20	20	0	20	0	0	40	40											20	20				
		Tungsten	60	40	0	40	100	100	100	100											60	60				
Protanopia	5	Daylight	40	0	0	0	0	0	0	0											0	0				
		Tungsten	40	0	0	0	0	0	60	40											20	20				
All types of defective color vision	22	Daylight	50	18	0	18	23	0	32	27											27	27				
		Tungsten	68	32	9	36	55	50	77	73											32	41				

* Percentage of subjects with each type of defective color vision passing each plate of the Ishihara test, editions 5, 6 and 9 (British reprint). and the Ishihara plates in the American Optical Company's test when the test was administered under daylight and under tungsten light. Each plate is designated by series number and by plate number as it appears in the edition under consideration.

Ishihara test when it is incorrectly administered under tungsten illumination.

2. Without our entering into a detailed analysis of the changes produced in the appearance of each plate as the result of the change in illuminant from daylight to tungsten light the following comments are probably justified with regard to the factors which produce a higher percentage of normal responses among subjects with defective red-green vision when the test is administered under tungsten illumination.

Series 1 and 2 (transformation pattern).—In the plates of series 1 one or two digits, composed in general of blue-red and yellow-red disks, are seen by the subject with normal color vision on a background composed of blue-green and yellow-green disks. To the subject with defective red-green vision, to whom the yellow-red portion of the digit and the yellow-green background have little if any differentiation, only the blue-red and blue-green disks stand out from the background, forming for him a bluish pattern on a yellowish background. The pattern is thus transformed for the subject with defective color vision into a different one from that seen by the subject with normal color vision; e.g., from an 8 to a 3. In the plates of series 2 approximately the same combination of colors is used but with background and pattern reversed; that is, blue-green and yellow-green disks form the digits on a background of blue-red and yellow-red disks. Again, the pattern seen by the subject with defective red-green vision is formed by those disks which have a blue component. Since the effect of tungsten light is to enhance red and yellow pigments, to dull green and blue pigments and to shift the hue of mixed colors toward the longer wavelengths, the digits seen by the subject with normal color vision are emphasized, and those seen by the subject with defective red-green vision are dulled, by the use of this illuminant. The result is that fewer persons with defective red-green vision give the expected response when the illumination is changed from daylight to tungsten light. Instead, they more frequently give the normal response and obtain a passing score, as is shown in table 1; or else they often see no digit at all and fail the test—a change in response which is not shown in table 1 but is revealed by an analysis of individual responses.

The plates of series 2 are most affected by the change in illumination as reproduced in the ninth edition (British reprint) of the Ishihara test and in the American Optical Company's selection of Ishihara plates—some of the plates of series 2 of these editions being passed by all the deuteranomalous and deuteranopic subjects.

Series 3 and 4 (vanishing digit).—In the plates of these series the contrast between digit and background is obviously intensified under tungsten light as compared with daylight. The result is that fewer

subjects with defective color vision fail to read the digit; thus, more succeed in passing the plates.

Series 5 (hidden digit).—In the plates of this series the digit, which is supposedly seen only by subjects with defective color vision, is bluish. Under tungsten illumination this coloration is less pronounced than under daylight. The result is that fewer persons with defective color vision see this bluish "hidden digit," and thus, again, more of them give the normal response (no digit seen) and pass the plates. It may be mentioned that this hidden digit is seen under daylight illumination by many having normal color vision, who by this reaction fail to pass the plate. It is rarely visible to the subject with normal color vision, however, when viewed by him under tungsten light.

In all editions of the Ishihara test studied the responses given by the deuteranomalous and deuteranopic subjects to the plates of this series are significantly affected by the change in illumination. Most deuteranopic subjects, and with some plates all the deuteranopic subjects, failed to see the pattern under tungsten illumination, thus passing the particular plate. The responses given by the protanomalous subjects and by the majority of the protanopic subjects, however, were not affected by the change of illumination. That is, they saw the hidden digit under both daylight and tungsten light, thus failing to pass the plate. The reason for this may perhaps be found in the tendency of protanomalous and protanopic subjects to see the hidden digit, which is bluish, as lighter than the background, which is in general composed of red, orange and yellow disks. These background colors, it will be remembered, appear darker to protanomalous and protanopic subjects than they do to deuteranomalous, deuteranopic and normal persons.

Series 6 (diagnostic plates).—These plates carry two digits (e.g., 26), one in red and one in red-purple disks, on a background of gray disks of different brightnesses. Protanopic subjects, who have a neutral band in the red of the normal color system, just too purplish to be a spectral red, are supposed to see only the red-purple digit (the 6); and deuteranopic subjects, who have a neutral band in the red-purple zone of the normal color system, well outside the limits of the visible spectrum, are supposed to see only the red digit (the 2). The effect of the incorrect use of tungsten illumination on the plates of this series is to intensify the red component of both digits and to dull the blue component of the red-purple digit. The result is that more subjects with defective color vision see both digits correctly against their gray background, and thus more succeed in passing at least some of the plates of this series. This result occurred among deuteranomalous, protanomalous and protanopic subjects. It did not occur with any of our deuteranopic subjects.

The effect of the change in quality of the illumination from daylight to tungsten light on the diagnostic possibilities of the plates of series 6 is discussed in a later section.

EFFECT OF QUALITY OF ILLUMINATION ON PERFORMANCE SCORES ON THE ENTIRE TEST

Table 2 shows the performance scores obtained on the entire test for each of the editions of the Ishihara test under consideration and for the 10 Ishihara plates in the American Optical Company's test when administered under daylight and under tungsten light. In this table are given for each type of defect in color vision (*a*) the average score achieved by the group, (*b*) the median, or middle, score for each group and (*c*) the range of scores from lowest to highest achieved by the subjects within each group. A score of 100 indicates that correct responses were given to all the plates of the test; a score of 0, that no correct responses were given, and scores between 0 and 100 indicate the percentage of plates to which correct responses were given. As in table 1, the first four rows of figures in roman type under each edition give the data for each type of defective color vision when the test is administered under daylight; the first four rows in boldface under each edition give the data when the test is administered under tungsten light. These data thus demonstrate the effect of changing the quality of illumination from daylight to tungsten light on the scores achieved on the entire test for the subjects with each of the types of defective color vision. The two bottom rows of figures under each edition show this effect for the subjects with defective color vision as a group and demonstrate the significance of performance scores on the entire test for the simple detection of the presence of defective color vision when the test is administered under the two types of illumination.

The findings presented in table 2 may be summarized as follows:

1. With the single exception of the protanomalous subjects tested with the seventh edition of the Ishihara test, the average performance scores are always higher when the test is administered under tungsten light than when it is administered under daylight. The improvement in score is greatest for deuteranomalous subjects, particularly with the fifth edition of the test, and for deuteranopic subjects, particularly with the Ishihara plates used by the American Optical Company. The change in average score with protanomalous and protanopic subjects is of little consequence for all editions, except perhaps the American Optical Company's Ishihara plates.

2. With the exception of the protanomalous subjects when tested with the seventh edition and of the protanopic subjects when tested with the ninth edition, the median performance scores also are higher when

the test is administered under tungsten light. Again, the increase in score is highest with deuteranomalous and deuteranopic subjects.

3. In conformity with the higher performance scores attained by most subjects with defective red-green vision under tungsten light,

TABLE 2.—*Effect of Quality of Illumination on Performance Scores on the Ishihara Test for Each Type of Color Defective Vision.**

Type of Defective Color Vision	Number of Subjects	Quality of Illumination	Scores		
			Average	Median	Range of
Fifth Edition					
Anomalous trichromasy					
Deuteranomaly	7	Daylight	20	17	0-58
		Tungsten	59	58	25-92
Protanomaly	5	Daylight	18	17	8-33
		Tungsten	28	33	8-42
Dichromasy					
Deuteranopia	5	Daylight	0	0	0
		Tungsten	15	8	8-25
Protanopia	5	Daylight	13	17	8-17
		Tungsten	15	17	0.25
All types of defective color vision	22	Daylight	14	17	0.58
		Tungsten	32	25	0-92
Seventh Edition					
Anomalous trichromasy					
Deuteranomaly	7	Daylight	18	17	0-33
		Tungsten	44	42	21-67
Protanomaly	5	Daylight	8	12	0-17
		Tungsten	7	4	4-17
Dichromasy					
Deuteranopia	5	Daylight	2	4	0- 4
		Tungsten	26	25	13-37
Protanopia	5	Daylight	4	0	0-17
		Tungsten	7	4	4-17
All types of defective color vision	22	Daylight	9	6	0-33
		Tungsten	23	19	4-67
Ninth Edition (British Reprint)					
Anomalous trichromasy					
Deuteranomaly	7	Daylight	19	21	0-42
		Tungsten	30	25	21-54
Protanomaly	5	Daylight	6	4	0-12
		Tungsten	11	12	0-21
Dichromasy					
Deuteranopia	5	Daylight	2	0	0- 8
		Tungsten	27	29	21-29
Protanopia	5	Daylight	5	4	0-17
		Tungsten	9	4	4-17
All types of defective color vision	22	Daylight	9	4	0-42
		Tungsten	20	21	0-54
Ishihara Plates, American Optical Company's Test					
Anomalous trichromasy					
Deuteranomaly	7	Daylight	50	50	20-70
		Tungsten	71	80	50-100
Protanomaly	5	Daylight	8	0	0-30
		Tungsten	24	20	10-40
Dichromasy					
Deuteranopia	5	Daylight	18	10	0-50
		Tungsten	66	60	40-90
Protanopia	5	Daylight	4	0	0-10
		Tungsten	18	20	0-30
All types of defective color vision	22	Daylight	23	10	0-70
		Tungsten	47	45	0-100

* Performance score is percentage of the plates to which correct responses were given.

the range of scores from lowest to highest is in general shifted upward and in many instances is widened when this illuminant is used. This effect is shown in the last column of table 2. As is seen in this column, the upper value of this range for deuteranomalous subjects tested with the fifth edition of the Ishihara test is shifted above the critical score of 60, the score that was established in an earlier report [1] as the dividing line between normal performance and the performance of subjects with defective color vision when the test is properly administered under daylight.

An analysis of individual cases in this group of deuteranomalous subjects reveals that of the 7 tested, 3, or 42 per cent, would not have been screened from the normal if the test had been administered under tungsten illuminant. The scores for these 3 subjects jumped, respectively, from 17 to 92, from 58 to 83 and from 25 to 75 when the illumination was shifted from daylight to tungsten light. In other words, the criterion of 60 per cent for the performance on the fifth edition of the Ishihara test cannot be used when tungsten light is employed.

In order to show that the Ishihara test is not unique among pseudo-isochromatic tests in being influenced by the quality of illumination under which the test is administered, the following brief statement of results obtained with the complete American Optical Company test [8] may be given. As was the case with the Ishihara test, only the plates designed for literate subjects were used. For the same 22 subjects with defective color vision whose comparative scores on the Ishihara test are given in this report, the average scores and ranges of scores for the entire test of the American Optical Company obtained when the illuminant was changed from daylight to tungsten light are summarized.

Deuteranomaly.—The average score increased from 37 to 52; the range of scores changed from 28 to 55 to 30 to 70;

Protanomaly.—The average score increased from 28 to 33; the range of scores changed from 20 to 35 to 25 to 43;

Deuteranopia.—The average score increased from 17 to 35; the range of scores changed from 15 to 23 to 25 to 48;

Protanopia.—The average score increased from 16 to 18; the range of scores changed from 5 to 20 to 13 to 25.

The improvement in performance scores on the American Optical Company test when the illuminant was shifted from daylight to tungsten almost precisely parallels that noted on the Ishihara test; that is, the improvement was most marked for deuteranomalous and deuteranopic subjects.

EFFECT OF QUALITY OF ILLUMINATION ON THE DIFFERENTIAL CLASSIFICATION OF DEUTERANOPIA AND PROTANOPIA, DEUTERANOMALY AND PROTANOMALY

As was stated previously, the plates of series 6 of the Ishihara test were designed as a means of classifying the type of defect among subjects with defective red-green vision. On each plate of this series there are two digits, the left one composed of red disks of less brightness than the background (gray) disks, and the right one composed of red-purple disks of approximately the same brightness as the background disks. According to Ishihara, the subject with the deuteranopic type of defective red-green vision misses the red-purple digit and is able to read only the lighter red digit, since this type has a neutral band in the red-purple of the normal color system and has luminosity values that approximate those of normal subjects. The subject with the protanopic type of defective red-green vision, on the other hand, misses the lighter red digit and is able to read only the red-purple digit, since this type has a neutral band nearer the red of the spectrum and perceives red as darker in brightness than do normal and deuteranopic subjects. The effectiveness of these plates for the classification of the type of defect in red-green vision, as reproduced in the fifth, seventh and ninth editions of the test, was analyzed in previous reports [9] when the test was administered under daylight, as directed by Ishihara. Table 3 gives the results for these editions of the test when the illumination was changed from daylight to tungsten light. This change in illumination causes a noticeable shift in the hue of the red-purple digit toward red and a shift in the hue of the red digit toward yellow-red.

In scoring the responses to these plates, we used the criterion previously discussed.[1] That is, a defect in red-green vision was called "classified" when one digit was read correctly and the other was not seen at all or was read incorrectly. When both digits were read correctly, when neither was read correctly or when one was read incorrectly and the other was not seen at all, the defect was called "not classified." In short, a "hit and miss" response is necessary in order to utilize any plate of series 6 as a test for classification of type of defect in red-green vision. It seems reasonable to require a "hit and miss" response on at least 50 per cent of the plates used for this purpose.

Table 3 indicates the results obtained.

1. The percentage of deuteranomalous subjects correctly classified was decreased by the use of tungsten illumination. For the fifth edition the decrease was from 86 to 57 per cent; for the seventh edition, from 57 to 43 per cent. For the ninth edition there was no change. Since with this type of subjects with defective red-green vision no incorrect

9. Hardy, Rand and Rittler (footnotes 1 and 4.)

classifications were made, the percentages for which no classification could be made were proportionately increased. This result was due to the ability of more of the deuteranomalous subjects to read both the red and the red-purple digit under tungsten illuminant, when only the red digit was seen under daylight. Apparently, the hue of the

TABLE 3.—*Effect of Quality of Illumination on the Differential Classification of Deuteranopia and Protanopia, Deuteranomaly and Protanomaly.**

Type of Defective Color Vision	Number of Subjects	Quality of Illumination	Percentage Correctly Classified by at Least 50% of the Plates	Percentage Incorrectly Classified by at Least 50% of the Plates	Percentage Not Classified by at Least 50% of the Plates
		Fifth Edition			
Anomalous trichromasy					
Deuteranomaly	7	Daylight	86	0	14
		Tungsten	57	0	43
Protanomaly	5	Daylight	80	0	20
		Tungsten	0	80	20
Dichromasy					
Deuteranopia	5	Daylight	100	0	0
		Tungsten	100	0	0
Protanopia	5	Daylight	60	0	40
		Tungsten	40	20	40
		Seventh Edition			
Anomalous trichromasy					
Deuteranomaly	7	Daylight	57	0	43
		Tungsten	43	0	57
Protanomaly	5	Daylight	40	20	40
		Tungsten	0	60	40
Dichromasy					
Deuteranopia	5	Daylight	100	0	0
		Tungsten	100	0	0
Protanopia	5	Daylight	60	0	40
		Tungsten	0	20	80
		Ninth Edition (British Reprint)			
Anomalous trichromasy					
Deuteranomaly	7	Daylight	86	0	14
		Tungsten	86	0	14
Protanomaly	5	Daylight	60	0	40
		Tungsten	0	60	40
Dichromasy					
Deuteranopia	5	Daylight	100	0	0
		Tungsten	100	0	0
Protanopia	5	Daylight	60	0	40
		Tungsten	40	40	20

* Analysis of the value of the plates of series 6 of the fifth, seventh and ninth (British reprint) editions of the Ishihara test as a means of differentiating types of defective red-green vision when the test is administered under daylight and under tungsten light.

red-purple digit was shifted by the yellower illumination into a color region to which these subjects were more sensitive.

2. The percentage of deuteranopic subjects correctly classified was not changed by the use of tungsten illumination. All the deuteranopic subjects were correctly classified by at least 50 per cent of the plates of series 6 when both illuminants were used.

3. In the classification of protanomalous and protanopic subjects, the deleterious effect of the yellower illumination was most strikingly demonstrated. The result was a decrease in the percentage of correct classifications and, more significantly, an increase in the occurrence of incorrect classifications. In the latter case, the red digit, which was not seen by some of the protanomalous and protanopic subjects under daylight illumination, was seen under tungsten illumination because under this light its hue was apparently shifted toward the yellow by a sufficient amount to bring it into a color region to which these subjects were more sensitive, whereas the red-purple digit, usually seen by them under daylight illumination, was not seen under tungsten light because its hue was apparently shifted toward red by a sufficient amount to bring it into the color region to which these subjects were less sensitive. Thus, an incorrect classification of deuteranopia, instead of the correct one of protanopia, was more frequently obtained under tungsten light than under daylight. This result was particularly frequent for the protanomalous subjects when tested with all three editions of the Ishihara test.

CONCLUSIONS

In spite of the small number of subjects used in this comparative study of the effect of quality of illumination on the results of the Ishihara test taken as typical of polychromatic and pseudoisochromatic tests the following conclusions seem to be justified when the test is incorrectly administered under tungsten light, instead of under daylight, as is directed by the author of the test:

1. When tungsten light is used as the illuminant, the performance scores attained by all the deuteranomalous and deuteranopic subjects tested are higher than when daylight is used. The responses of protanopic and protanomalous subjects are little affected by this change in quality of illumination.

2. A substantial number of deuteranomalous subjects are sufficiently aided in giving normal responses by the incorrect use of tungsten light to take them out of the class of persons with defective color vision when judged by the performance score; that is, their scores fall within the normal limits established for daylight illumination.

3. There is a decrease in the number of subjects who are correctly classified for type of defective red-green vision when tested under tungsten light, as compared with the number so classified when tested under daylight, and an increase in the number of protanomalous and protanopic subjects who are incorrectly classified.

We wish to stress once more the critical importance of strict observance of correct conditions of illumination during the administration of polychromatic tests which employ test material seen by reflected light.

CYCLOFUSIONAL MOVEMENTS

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IT IS generally recognized that cyclofusional movements of the two eyes can occur in the interest of maintaining single binocular vision, especially in the unnatural and the forced optical conditions that, for example, can be produced in the stereoscope. A historical survey shows that this recognition has come not without controversy. Nagel,[1] it seems, was the first to point out that a cyclotorsional movement took place when horizontal lines, observed in the stereoscope, were rotated in opposite directions. Independently, von Helmholtz [2] found the same evidence with an arrangement of prisms when rotating the images in the two eyes in opposite directions. At the same time, Hering,[3] while not denying the possibility of such movements, was unconvinced by the experiments of Nagel and von Helmholtz, but more especially by his own attempts to find such movements with a stereoscope. Only later, after Nagel had repeated both the experiments of von Helmholtz and his own previous work [4] and had verified the results, did Hering find what he considered to be the weakness of his experiments and then accept the evidence for cyclofusional movements.[5]

The classic experiments which demonstrate that cyclofusional movements can be enforced optically are those of Hofmann and Bielschowsky.[6] In these, cards of identical print were used on the

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1. Nagel, A.: Das Sehen mit zwei Augen, Leipzig, C. F. Winter, 1861, p. 51.

2. von Helmholtz, H.: Ueber die Augenbewegungen, Heidelberg Jahrb. d. Literatur, 1865, p. 258; Helmholtz's Treatise on Physiological Optics, translated and edited by J. P. C. Southall, Rochester, N. Y., The Optical Society of America, 1924, vol. 3, pp. 59-62.

3. Hering, E.: Die Lehre vom binocularen Sehen, Leipzig, Wilhelm Engelmann, 1868; cited in Wissenschaftliche Abhandlungen, Leipzig, Georg Thieme, 1931, vol. 2, pp. 56-62; Ueber die Rollung des Auges um die Gesichtslinie, Arch. f. Ophth. **15** (pt. 1):1-16, 1869.

4. Nagel, A.: Ueber das Vorkommen von wahren Rollungen des Auges um die Gesichtslinie, Arch. f. Ophth. **14** (pt. 2):228-246, 1868.

5. Hering, E.: Der Raumsinn und die Bewegungen des Auges, in von Hermann, L.: Handbuch der Physiologie, Leipzig, F. C. W. Vogel, 1879, vol. 3, p. 504.

6. Hofmann, F. B., and Bielschowsky, A.: Der Willkür entzogenen Fusionsbewegungen der Augen, Arch. f. d. ges. Physiol. **80**:1-40, 1900; cf. pp. 20-28.

two sides of a haploscope. Above the center of one card and below the center of the other, horizontal lines were drawn. On looking into the haploscope, one sees a single card of print with two horizontal lines that appear parallel. In slowly rotating the cards in opposite directions about their centers, it was found that these lines continued to appear parallel until the cards had been rotated even by as much as 5 to 8 degrees, that then they slowly deviated from parallelism and, finally, that the print was seen double. It is clear that so long as the lines appeared parallel with this rotation the eyes must have been making cyclotorsional movements at the same rate.

In America, Perry,[7] in 1895, and Stevens,[8] in 1897, described methods for measuring cyclofusional amplitudes (the limits of torsion through which the targets can be rotated and the print remain single) when using a stereoscopic device. In 1926 Ames[9] reported experiments also showing the existence of cyclofusional movements with lines and with stereoscopic pictures, and he later suggested that the cyclofusional amplitudes be included in any thorough study of ocular measurements.[10] Verhoeff,[11] however, continued to deny, even until the early 1930's, the possible existence of cyclofusional movements. He accounted for cyclofusional amplitudes entirely on the basis of Panum's fusional areas. That fusional areas do contribute to the cyclofusional amplitudes cannot be doubted,[12] and this was recognized by Hofmann and Bielschowsky. In 1934 Verhoeff repeated Hofmann and Bielschowsky's experiment with improved apparatus and verified their results completely.

Using a telescope to observe distinctive markings on the iris, Brecher,[13] in 1934, reported measuring the actual cyclorotations of

7. Perry, C. H.: Rotation in Oblique Astigmatism, Ophth. Rec. **5**:175-178, 1895-1896.

8. Stevens, G. T.: The Directions of the Apparent Vertical and Horizontal Meridians of the Retina, Arch. Ophth. **26**:181-203, 1897.

9. Ames, A., Jr.: Cyclophoria, Am. J. Physiol. Optics **7**:3-38, 1926.

10. Ames, A., Jr., and Gliddon, G. H.: Ocular Measurements, Tr. Sect. Ophth., A. M. A., 1928, pp. 102-175.

11. Verhoeff, F.: (*a*) A Description of the Reflecting Phorometer and a Discussion of the Possibilities Concerning Torsions of the Eyes, Tr. Am. Ophth. Soc. **8**:490-503, 1899; (*b*) A New Instrument for Measuring Heterophoria and the Combining Power of the Eyes, Bull. Johns Hopkins Hosp. **10**:87-92, 1899; (*c*) A Theory of Binocular Perspective and Some Remarks upon Torsions of the Eyes, Ann. Ophth. **2**:201-229, 1902; (*d*) Cycloduction, Tr. Am. Ophth. Soc. **32**:208-228, 1934.

12. Tschermak, A.: Augenbewegungen, in Bethe, A.; von Bergmann, G.; Emden, G., and Ellinger, A.: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1930, vol. 12, pt. 2, pp. 1001-1094.

13. Brecher, G. A.: Die optokinetische Auslösung von Augenrollung und rotatorischem Nystagmus, Arch. f. d. ges. Physiol. **234**:13-28, 1934.

the eyes in haploscopic cycloduction tests. Against this, however, in a brief and incomplete note, Beasley and Peckham,[14] when using a similar technic, reported that no actual torsions could be observed.

No longer is there any question that cyclofusional movements can be enforced. Evidence has also been produced to show that parallel, or conjugate, torsional movements (as against the opposing, or disjunctive, torsional movements involved in cyclofusional amplitudes) can, under appropriate conditions, be induced optically,[15] and even optokinetically.[13] These studies, however, do not include the parallel compensatory torsions that accompany changes in positions of the head and body, movements which are thoroughly covered in the literature in other connections.

All experiments dealing with enforced cyclofusional movements involve the use of similar patterns in a stereoscope or haploscope or of prism and mirror devices, by which the image for one eye can be rotated about its optic axis with respect to the image of the other eye. The essential facts regarding these movements may be briefly summarized as follows: There is a small lag in the cyclotorsions of the eyes behind the actual torsions of the images, and hence these movements are to be considered delayed and relatively slow movements. The amplitude within which the ocular movements can accompany the torsions of the targets varies greatly with the amount of detail in those patterns, being least for a single horizontal line and at a maximum for print or for stereoscopic pictures. A single vertical line has not been considered suitable on account of the influence of stereopsis, which makes it appear inclined toward or away from the observer.

Cyclofusional movements, like the other fusional movements, are subject to training, have residual tendencies after a movement in one direction, show varying reaction times and vary with the individual subject. The two eyes make essentially equal but opposite cyclotorsions, even though only the image of one eye is rotated,[6] a fact indicating that the innervations leading to those movements are supplied equally to the two eyes. Herzau[16] showed, moreover, that the cyclofusional movements as measured by the amplitudes were independent of an enforced vertical divergence of the two eyes and that, therefore, these movements arise in an independent muscular synergy.

One concludes, then, that in addition to the apparent torsional movements that occur according to Listing's law, or those parallel reflex

14. Beasley, W. C., and Peckham, R. H.: An Objective Study of Cyclotorsion, Psychol. Bull. **33**:741-742, 1936.

15. Noji, R.: Ueber optisch erzwungene parallele Rollungen der Augen, Arch. f. Ophth. **122**:562-571, 1929.

16. Herzau, W.: Ueber das Verhältnis von erzwungener Vertikaldivergenz und Rollung bei der Fusion, Arch. f. Ophth. **122**:59-74, 1929.

cyclotorsional movements that tend to compensate for inclinations of the head and body, or those changes in torsion associated with convergence and elevation and depression of the eyes, the external muscles of the eyes can cooperate in the interest of maintaining binocular single vision to provide cyclotorsions about the visual axes, which may remain fixed. These movements fall into the category of reflex movements, characterized by Hofmann [17] as "psycho-optical" reflexes in that they depend on the attention of the observer and yet when that attention is given they act as reflex movements and can be neither induced nor suppressed spontaneously.[18]

In the present paper, a series of experiments will be described which provide a new contribution to knowledge of the nature of these movements.[19] All the evidence from these experiments shows that cyclofusional movements of the eyes take place in the interest of fusion more freely than has heretofore been realized. These movements are determined in the main by the type and orientation of the configurations in the visual field, especially by the vertical contours of the configuration and, to a small extent, by attention. In complex fields of contours demanding torsions of different amounts, these movements tend to be a compromise of the antagonistic compulsions to fusion.

Suppose, as is illustrated in figure 1, that the two eyes are fixating a line which is perpendicular to the visual plane, and suppose, further, that this line appears precisely vertical to the observer—vertical in the sense that the top does not appear nearer or farther away than the bottom. This means, then, that the images of this line fall on meridians of the retinas of the two eyes which are stereoscopically zero; that is, the horizontal disparity between the images of any point on the line

17. Hofmann, F. B.: Die Lehre vom Raumsinn, in Graefe, A., and Saemisch, T.: Handbuch der gesamten Augenheilkunde, Berlin, Julius Springer, 1925, vol. 3, chap. 13, p. 312.

18. W. Feilchenfeld (Ueber die Wilkürlichkeit der Augenbewegungen insbesondere der Rollung der Augen, Klin. Monatsbl. f. Augenh. **88**:514-517, 1932) believes the evidence is still inconclusive that torsional movements can never take place voluntarily.

19. The experiments were part of a study of the space eikonometer, in which it was recognized that cyclotorsions of the eyes could interfere with the measurement of meridional aniseikonic errors at oblique axes. The literature referred to in this study is as follows: (*a*) Ames, A., Jr.: The Space-Eikonometer Test for Aniseikonia, Am. J. Ophth. **28**:248-262, 1945. (*b*) Ogle, K. N.: Association Between Aniseikonia and Anomalous Binocular Space Localization, Arch. Ophth. **30**:54-64 (July) 1943. (*c*) Ogle, K. N., and Madigan, L. F.: Astigmatism at Oblique Axes and Binocular Stereoscopic Spatial Localization, ibid. **33**:116-127 (Feb.) 1945. (*d*) Burian, H. M., and Ogle, K. N.: Meridional Aniseikonia at Oblique Axes, ibid. **33**:293-309 (April) 1945. (*e*) Ogle, K. N.: Theory of Space-Eikonometer, J. Optic. Soc. America **36**:20-32, 1946.

is zero. These meridians in the strictest functional sense are, therefore, said to be corresponding meridians.

Now, if the line is inclined with the top nearer to the observer, the retinal images are no longer vertical, but each is deviated in a rotary sense in an opposite direction about the axis of fixation (see insert, fig. 1). The line will appear inclined in space because of the stereoscopic response to the horizontal disparities between the images of the two eyes which exist for all parts of the line except the point of fixation. The total angular deviation between the images in the two eyes will be designated as a declination and indicated by δ. The term "declina-

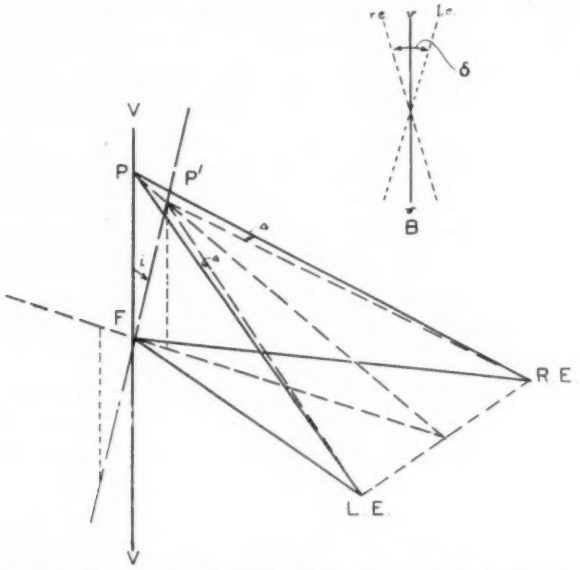

Fig. 1.—Perspective drawing illustrating the disparities introduced by an inclined line in space and the equivalent rotation of the images of the two eyes.

tion," which was coined by Stevens,[20] is used here to designate the total angular deviation between the images of the two eyes measured from those meridians of the eyes which determine the stereoscope vertical.

The angle of inclination, ι, of the line, measured from the vertical, is related to the angle of declination, δ by

$$\tan \iota = \frac{b}{2a} \tan \delta \qquad (1)$$

where b is the visual distance and $2a$ is the interpupillary distance

20. Stevens, G. T.: A Treatise on the Motor Apparatus of the Eye, Philadelphia, F. A. Davis Company, 1906.

and where b is large as compared with a.[19e] The tabulation which follows shows approximate values of δ for various inclinations of the line, computed from this formula for a visual distance of 2 meters and for an interpupillary distance of 64 mm. It will be seen that

ι	δ	ι	δ	ι	δ
0°	0.00°	20°	0.60°	40°	1.40°
5°	0.14°	25°	0.76°	45°	1.66°
10°	0.28°	30°	0.94°	50°	1.90°
15°	0.44°	35°	1.14°	55°	2.36°

small angles of declination, δ, will be associated with relatively large angles of inclination, ι. Even an inclination of 10 degrees will be associated with a declination between the retinal images of only 0.3 degrees. The apparent magnitude of the inclination for a given declination will, of course, be greater as the visual distances increase.

In normal circumstances, and provided the positions of the eyes remain unchanged, the inclination of the line for a given δ should be correctly seen in stereoscopic perception. If, however, owing to a fusional compulsion from the disparate images of the line, a cyclotorsional movement of τ, degrees occurs (in figure 1, an incyclotorsional movement), to bring the images nearer corresponding meridians, the effective declination, δ, will be reduced, and even eliminated. Then the inclined line would (or would tend to) appear vertical.

This is exactly what happens if a long white thread uniformly illuminated is inclined in the median plane and observed through unlike apertures in a dark room where no empiric clues or motives for spatial localization are evident. Only as the angle of inclination becomes large will the thread appear inclined, and even then only by a small degree. Moreover, if, in addition, a horizontal white thread is stretched in the field of view along the axis of rotation of the inclined thread, the latter does then appear inclined, though perhaps not to the full extent. At times, with these two lines, the perception will seem confused and unsteady. A cyclofusional movement in this case that would reduce the declination between the images of the inclined line would also introduce a declination between the images of the horizontal line, which, in turn, would exert a compulsion for a torsion in the opposite direction. Thus, the addition of the horizontal line dampens or stabilizes the degree to which cyclofusional movements can overcome the declination between the images of the inclined line.

Such subjective experiments are unsatisfactory, and it is almost impossible to eliminate the empiric factors of varying brightness and change in angular size, which increase the more the line is inclined. Furthermore, one is restricted in the degree of inclination that can be obtained without the subjects seeing the frame which supports the line. To overcome these difficulties in the experiments to be described, all configurations used in the field of view were fixed in a vertical

position, and the declinations between the images were introduced optically.

The optical device, which will be designated as the geared unit,[19] consists of two matched, meridional size (afocal magnifying) lenses that are mounted in geared rings. The dimensions of the two rings are such that the teeth mesh and the separation of the lenses (which are 44 mm. in diameter) will correspond to an average interpupillary distance. When activated by a small pinion alined to one of the rings, the two lenses will then rotate equally but in opposite directions. A suitable drum attached to the shaft of the pinion is calibrated to read directly the change in declination for vertical (and horizontal) lines in tenth of a degree. The drum reads zero when the axes of the lenses are parallel and vertical.

A meridional size lens magnifies the image seen through it in one meridian only and consequently will introduce rotary deviations of the images of all lines in space not parallel with or perpendicular to the

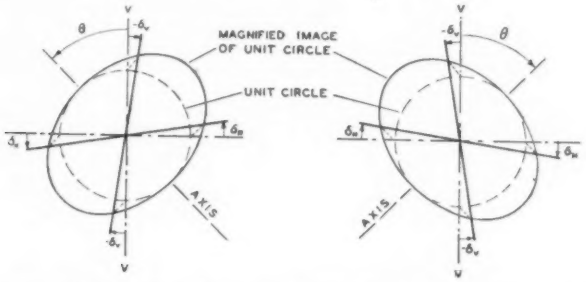

Fig. 2.—Illustration of how the geared meridional size lenses introduce a rotary deviation between the images of vertical and horizontal lines.

meridian of magnification. When the axis of the lens is placed obliquely, the images of vertical and horizontal lines will always be deviated toward the meridian of magnification, almost equally but in directions opposite each other (scissors effect) (fig. 2). The magnitude of the declination angle, δ, between the images of the vertical lines (and horizontal lines, though the declination will be in an opposite direction) will be related to the angle Θ, through which the two geared lenses have been rotated, by

$$\tan \delta = 2 \frac{M - 1}{M + 1} \sin 2\Theta \qquad (2)$$

where M is the magnification of the lenses.[21] For most of the experiments 2 per cent meridional size lenses were used. For small angles

21. Ogle, K. N.: Meridional Magnifying Lens Systems in the Measurement and Correction of Aniseikonia, J. Optic. Soc. America **34**:302-312, 1944.

of rotation, δ is approximately 0.034 degree per degree Θ, with a maximum δ (when $\Theta = \pm 45°$) of about 1.1 degree. If the lenses are rotated so that the axes converge above the unit, the declination of the images of the vertical lines (δ_v) will be taken as positive; if rotated to converge down, it will be taken as negative. No size differences between the images of the two eyes will be introduced by the unit in the vertical or the horizontal meridian. On a special lens-testing instrument [22] these units were calibrated carefully, not only for the distance at which they were to be used before the eyes but also for the particular viewing distance used.

In the series of studies to be described, the nature of the cyclofusional movements in any given experiment will be deduced from the data that depend on the stereoscopic perception of certain test configurations in the field of view as influenced by the introduction of declinations. The investigation is in three parts, dealing with (1) the determination of the stereoscopic thresholds to changes in declination, (2) the determination of the apparent orientation of the test configurations as perceived stereoscopically and (3) the statistical results of a measurement obtained on nearly 400 subjects with a fixed (space eikonometer) test configuration.

For the special studies in the investigation, 3 subjects were used, whose ocular characteristics are summarized in the following tabulation:

Subject	Uncorrected Visual Acuity	Refractive Error (Subjective Measurement)	Heterophoria at 6 Meters	P.D.* mm.
V. J. E.	R. E. 20/15 L. E. 20/15	+ 0.12 D. cyl., ax 160 + 0.12 D. cyl., ax 180	1½Δ exophoria	62
N. W.	R. E. 20/15 L. E. 20/15	+ 0.25 D. sph. + 0.25 D. sph.	¾Δ exophoria ½Δ RH †	60
K. N. O.	R. E. 20/15+ L. E. 20/15	+ 0.25 D. sph.—0.25 D. cyl., ax 25 + 0.25 D. sph.—0.12 D. cyl., ax 10	¼Δ esophoria ¼Δ RH †	64

* P.D. indicates interpupillary distance.
† RH indicates right hyperphoria.

The greater part of the data were taken by the first and last subjects, who were trained in making stereoscopic observations.

STEREOSCOPIC THRESHOLDS TO INCLINED SPATIAL CONFIGURATIONS AND RELATION TO CYCLOFUSIONAL MOVEMENTS OF THE EYES

APPARATUS AND METHOD

In all determinations the head of the observer was held fixed with a suitable head rest and a wax bite (fig. 3), which prevented depth discrimination by the parallax associated with head movements. Directly in front of the observer, at a distance of 3 meters, a rigid wooden square frame (1.5 meters on a side) was set up in the vertical position with its plane at right angles to the median plane of the observer, and was centered with respect to that plane and at the level of the

22. Ogle, K. N., and Ames, A., Jr.: Ophthalmic Lens Testing Instrument, J. Optic. Soc. America **33**:137-142, 1943.

eyes of the observer. The various test configurations used in the experiments were supported within this frame. Suitable fluorescent or Lumiline lamps, screened from the observer, illuminated the configurations uniformly. The test elements were seen against the background of a black velvet cloth, which had been stretched tightly over a frame to prevent wrinkles. All details on the cloth, such as lint, which might be seen in binocular vision were also removed, so that the configurations would then be seen against a uniform black, shadowless background. Suitable screens and apertures restricted the field of view of the subject to the area of the fixed frame. The geared unit was suitably mounted before the eyes.

With these experimental conditions, in which insofar as possible, all empiric clues to depth perception are eliminated, measurements of the threshold of the subject to changes in declination principally as a function of stereoscopic acuity are carried out under optimal conditions and can be made with great accuracy. In the majority of the experiments described here, changes in declination and measurements of cyclofusional movements were under 1 degree. Ordinarily, cyclotorsions of this magnitude cannot be easily measured with any precision.

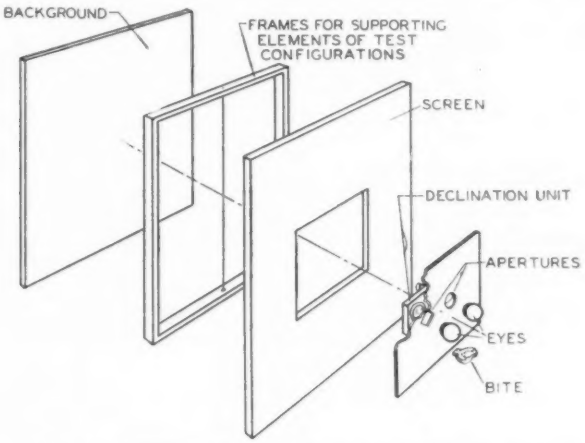

Fig. 3.—Perspective drawing of the apparatus used.

The method of constant stimuli, which is regarded as the most reliable of the three standard psychophysical methods, was used for determining the stereoscopic thresholds, and therefore the sensitivities, in these experiments.[23] This method as applied to the present investigation was as follows: The subject was presented, in a series, a large number of views of the configuration seen through the geared unit, which was set for any one of five steps of change in declination, chosen in random order. These five steps had been selected beforehand within a range of changes in declination at the limits of which the subject always responded correctly. A shutter device when lowered before one eye interrupted binocular observation of the configuration, though a small hole in the shutter permitted binocular fixation at the center. Changes in the declination unit were always made when the shutter was down. During the exposure the subject had only to

23. For a more detailed description of this method as applied here see a previous article (Stereoscopic Sensitivity to the Space-Eikonometer, Arch. Ophth. **34**:303-310 [Oct.] 1945).

judge whether the configuration was inclined and whether the top was nearer or farther. He was asked to guess if in doubt. Normal ocular movements were permitted while the judgment was being made. The exposure was usually limited to less than two seconds.

From the percentages of the judgments in each category of the change in declination for which the top of the configuration appeared "nearer" (or "farther") a typical psychometric curve was obtained. Examples are shown in figure 4. From this curve, as is customary, the measure of the threshold of the subject to the stimuli is taken as the standard deviation (σ), which is arrived at by statistical methods.[23] That declination for which 50 per cent of the judgments were "top farther away" and 50 per cent were "top nearer" indicates the most probable declination between the two eyes for which the test configuration appeared truly vertical. At this setting of the geared unit the judgments were pure guesswork, and the distribution found was due solely to chance. At those declination settings

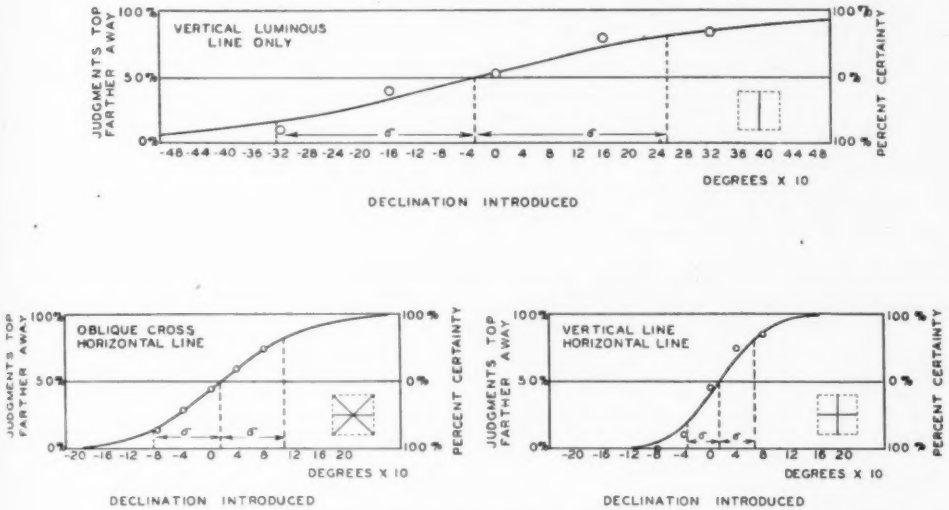
VERTICAL LUMINOUS LINE ONLY
JUDGMENTS TOP FARTHER AWAY
PERCENT CERTAINTY
100%
50%
0%
σ
-48 -44 -40 -36 -32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32 36 40 44 48
DEGREES X 10
DECLINATION INTRODUCED
OBLIQUE CROSS HORIZONTAL LINE
-20 -16 -12 -8 -4 0 4 8 12 16 20
VERTICAL LINE HORIZONTAL LINE

Fig. 4.—Illustration of typical psychometric curves found in determining the stereoscopic thresholds to changes in declination between the images of the two eyes as seen in an apparent inclination of the test elements in a fore and aft sense, for three different test configurations. Data for V. J. E.

corresponding to the more extreme ends of the curve the subject responded with nearly 100 per cent certainty. Between the declination for the 50-50 point and the declination for the upper limits the proportion of judgments varied from that due chance to near certainty. From this curve, the threshold of response can be read off directly, depending on what percentage of certainty one chooses to consider as the threshold declination.

It must be borne in mind that, while this method of determining thresholds is considered preferable to others, it demands constant attention on the part of the subject and an unvarying criterion of judgment. Moreover, care must be taken that the results are not influenced by such factors as fatigue and distractions.

The six types of combinations of configurations used (a seventh having been studied previously [23]) are illustrated in figure 5. These are: (*A*) two points of light situated vertically, (*B*) a single vertical line, (*C*) a vertical line combined

with an oblique cross, (*D*) a vertical line combined with a horizontal line, (*E*) an oblique cross combined with a horizontal line and, finally, (*F*) an oblique cross combined with both a vertical and a horizontal line.

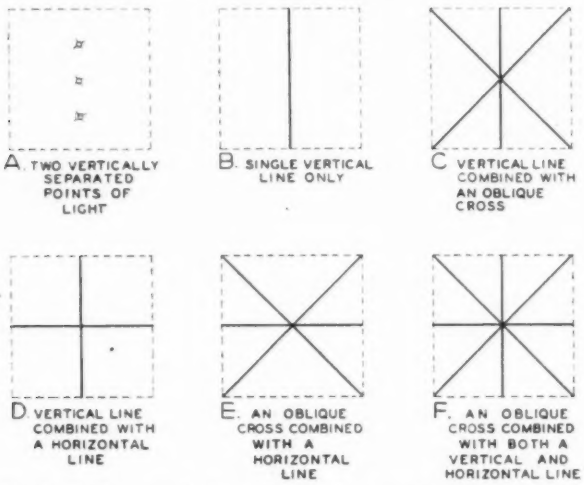
A. TWO VERTICALLY SEPARATED POINTS OF LIGHT
B. SINGLE VERTICAL LINE ONLY
C VERTICAL LINE COMBINED WITH AN OBLIQUE CROSS
D VERTICAL LINE COMBINED WITH A HORIZONTAL LINE
E. AN OBLIQUE CROSS COMBINED WITH A HORIZONTAL LINE
F. AN OBLIQUE CROSS COMBINED WITH BOTH A VERTICAL AND HORIZONTAL LINE

Fig. 5.—Configurations used in a study of stereoscopic thresholds to changes in declinations between the retinal images of the two eyes and of the influence of cyclofusional movements.

A represents two vertically separated points of light; *B*, a single vertical line, and *F*, an oblique cross combined with both a vertical and a horizontal line. combined with a horizontal line; *E*, an oblique cross combined with a horizontal line, and *F*, an oblique cross combined with both a vertical and a horizontal line.

TABLE 1.—*Results of Experiments to Find Apparent Stereoscopic Thresholds to Changes in Declination Between the Images of the Two Eyes for Various Configurations* *

Configuration	Standard Deviations, Degrees		
	V. J. E.	N. W.	K. N. O.
A. Point sources of light separated vertically 50 cm. (range in seven separate experiments)	0.278-0.560	0.344-0.548	0.360-0.552
The two point sources combined with a horizontal luminescent line	0.100-0.242*	.....	.....
B. Vertical luminous line only	0.270-0.790	.....	.....
Vertical white cord only	0.449-0.779	.....	.....
Vertical white rope only	0.450	0.272	0.304
C. Vertical white rope and oblique cross (white cord)	0.097	.....	.....
D. Vertical white rope and horizontal white rope	0.050	0.067	0.059
Vertical white string and horizontal white rope	.....	0.091-0.132	0.106-0.110
Vertical white rope and horizontal white string	0.048†	0.040	0.040
Vertical white rope and horizontal red string	0.049	0.066	0.063
Vertical white rope and horizontal blue thread	0.080	0.090	0.104
Vertical white rope and horizontal blue thread strand	0.128	0.137	0.064
E. Oblique white rope cross and horizontal white rope	0.083	.....	0.074
Oblique white string cross and horizontal white rope	0.109-0.126-0.112	.....	0.116-0.111
Oblique white thread cross and horizontal white rope	0.096†	.....	0.079
Oblique white rope cross and horizontal white string	0.091	.....	0.118
Oblique white rope cross and horizontal white thread	0.097	.....	0.068
F. Vertical white string, oblique white cross, horizontal white rope	.....	.....	0.100
Vertical red string, oblique white cross, horizontal white rope	0.091	.....	0.070
Vertical blue string, oblique red cross, horizontal white rope	0.076	.....	0.106

* The values given are the standard deviations (σ) in degrees of declination derived from the psychometric data as obtained with the method of constant stimuli.

† Psychometric curve is shown in figure 5.

RESULTS

The principal results of the various tests are presented in table 1. Typical psychometric curves for three experiments for one observer are illustrated in figure 4. The results can be summarized as follows:

A. Point Light Sources.—With the room completely darkened, two points of light were arranged vertically (fig. 5*A*). Each point light source was obtained by adjusting in a suitable housing a small, 6 volt lamp behind a pinhole in a small piece of lead foil. The housings were attached to a vertical rod so that not only would the two point sources be vertical and centered in the frame but their separations could be changed. The lights were adjusted for equal color and brightness. By means of a double throw tap key the two lights could be exposed for only short intervals. When they were not exposed for judgment on the part of the observer, another point source of light in the center would become automatically visible. This light provided a point for binocular fixation when the test stimuli were not exposed.

The results showed the stereoscopic threshold to changes in the declination between the images of the two eyes to be somewhat variable, but on the average it was a little under 0.5 degree. Strangely, however, when a definite declination beyond the midpoint previously found was introduced at the beginning of a series, and the point light sources were continuously observed and ocular movements permitted before the run was begun, it was found that the new psychometric curve obtained was almost identical with the previous curve, with no evidence of the displacement of the midpoint that would be expected. This failure of the curve to shift was early designated a "compensation," either psychologic (a change in the subjective criterion of verticality) or physiologic (a disjunctive cyclotorsion of the eyes). Either change, however, would be for the purpose of keeping the apparent position of the lights vertical. Physiologically, this could only mean that the images are kept nearest corresponding retinal meridians of the two eyes. It is important to point out, however, that this "compensation" did not take place if the change in declination was much greater than $\pm$ 1 degree, for beyond this no psychometric curve could be obtained at all. Nor did this compensation occur consistently without fixating ocular movements during the period of observation. Changing the separation of the points of light from an angular size of 2 degrees to one of 11 degrees did not affect the threshold significantly.

In view of the subsequent experiments, there is little question but that the compensatory effect is due to a cyclofusional movement of the eyes to correct the declination (disparities) between the images and to bring them to corresponding retinal meridians. With each exposure of the points of light for judgment, a compulsion for fusion must

exist; but since the exposure is relatively brief and the cyclofusional movements for such stimuli are slow, it is possible to obtain consistent judgments within a certain range. Obviously, however, with this play, back and forth, during the series of different declinations that were introduced, the apparent stereoscopic threshold of discrimination found would be expected to be relatively high.

B. Single Central Vertical Line.—Substituting a vertical plumb line of either cord or rope for the points of light (fig. 5 *B*) did not materially change the results. The "compensation" effect occurred more easily; but the time of exposure needed for a judgment decreased, and the threshold remained only slightly less than that for the point light sources for all 3 subjects.

C. Vertical Line and Oblique Cross.—By adding to the central vertical line an oblique cross consisting of intersecting white cords attached to the corners of the frame, the situation is stabilized (fig. 5 *C*).

It has been shown geometrically that the apparent inclination of an oblique cross should itself be unaffected by a meridional size lens placed at an oblique axis before one eye.[19e] In these experiments, therefore, changes in the adjustment of the geared unit will not themselves directly affect the orientation of the cross. This follows because equal declinations of the images of the two arms of the cross are introduced by lenses for both eyes.[24] However, a disjunctive cyclotorsion of the two eyes, and therefore of the images with respect to the retinas, would cause the plane of the cross to appear inclined. Thus, in this experiment the apparent inclination of the vertical line relative to the plane of the cross was the criterion of judgment.

The threshold value of the stereoscopic response was reduced to a declination of about 0.1 degree, and little or no "compensation" was found. It is clear that a cyclofusional movement to reduce the declination between the images of the vertical line would introduce declinations on the cross, which, in turn, would constitute stimuli for a movement in the opposite direction. The cross, therefore, stabilizes the movements.

D. A Vertical Line and a Horizontal Line.—Here the cross is removed, and a single horizontal cord is stretched across the frame and used with the vertical cord (fig. 5 *D*). It should be noted that several weights of cords were used for both lines.

With this configuration, it must be remembered that the geared unit introduces a declination between the images of both vertical and horizontal lines, though the images are deviated in opposite directions.

24. This follows from the fact that the declinations of the images of any two lines at right angles will be equal but opposite in direction. In the geared unit, these will be equal in the two eyes, and hence the cross will itself be unaffected.[19]

The two compulsions for a cyclofusional movement would, therefore, be antagonistic. If the fusional movement were to offset the horizontal deviation entirely, then the declination between the images of the vertical line would be increased to twice that introduced by the unit itself, and the vertical line should appear inclined nearly twice as much. One would expect, then, the "apparent" threshold of stereoscopic discrimination to be one-half as large as it would if no cyclofusional movement had occurred.

When the subject concentrated his attention on the horizontal line by looking back and forth along it and then made his judgment, the threshold was, indeed, reduced to nearly one half. One must note, however, that there was a tendency for lower "apparent" thresholds with weaker (of less contrast) horizontal lines, indicating that the compulsion for a cyclofusional movement had been reduced. In general, one would expect a compromise between the two stimuli for cyclofusional movements, the resultant depending on the relative degree of contrast and the attention of the subject and, also, on the physiologic "preference" for the correction of one type of declination rather than another.

E. An Oblique Cross and a Horizontal Line.—Here, the oblique cross was substituted for the vertical line and used with the horizontal line (fig. 5*E*). The subject was again asked to concentrate on the horizontal line and then to judge whether the cross was inclined in space, with the top nearer or farther away. The cross can appear inclined only when a disjunctive cyclotorsion of the images of the two eyes has taken place. Again, the threshold was of the order of 0.1 degree, and this shows that a cyclofusional movement had occurred in the direction of correcting the declination of the images of the horizontal line.

F. Oblique Cross Combined with a Vertical and a Horizontal Line.—A vertical line added to the configuration used in the preceding experiment (fig. 5*F*) introduced another antagonistic compulsion to fusion. However, the vertical line appeared inclined with respect to the plane of the cross, with a threshold to change in declination of, again, about 0.1 degree. Here, the oblique cross and the horizontal line would dampen any cyclofusional movement to correct the declination of the images of the vertical line, so that the threshold would tend to be uninfluenced by any cyclotorsion.

Comment.—The proof that the phenomena associated with changes in declination between the images of the two eyes, as they have been described, are due to cyclofusional movements and not to a psychologic change of criterion is in the experiments (1) with the configuration of a vertical and a horizontal line, in which the apparent threshold is

reduced to the order of one half, and (2) with the oblique cross and the horizontal line, in which if the cross appears inclined a cyclotorsion must have taken place.

STEREOSCOPIC PERCEPTION OF INCLINED CONFIGURATIONS AND CYCLOFUSIONAL MOVEMENTS

INCLINED CONFIGURATIONS

The sensitivity experiments were unsatisfactory in the sense that quantitative information was not found about the specific apparent inclination of a given configuration as influenced by the declination introduced.

However, in order that these data may be found, care must be taken as to how the experiments are set up. For example, suppose that within the supporting frame of the instrument an inner wooden frame is mounted so as to be rotatable about a horizontal axis in the plane of this frame and on the level of the subject's eyes. A suitable scale and indicator provide the means for knowing any given inclination of the inner frame. The inclination is taken as positive when the frame inclines back at the top. Within the inner frame a white cord is stretched between the centers of the top and the bottom member, so as to lie in the median plane of the subject and to have the same inclination as the frame. A white cord is then stretched in the axis of rotation of the frame. The configuration is then the same as that shown in figure 5 *D* except that the line which was vertical can now actually be inclined in space. The inclination of the frame can be adjusted by the subject by means of a hand wheel and cords.

The procedure was to introduce a given vertical declination between the images of the two eyes and then have the subject adjust the central cord so that it appeared truly vertical. Whenever possible, the subject was asked to lower the shutter when making the adjustments, so as to eliminate any kinesthetic influence of the moving line. The setting made by the subject was recorded by an assistant. From this inclination, the corresponding declination, δ, between the images of the two eyes for this inclination was then calculated from the formula

$$\tan \iota = (2a \tan \delta)/b$$

where, again, ι is the angle of inclination, $2a$ the interpupillary distances and b the visual distance.

Table 2 and figure 6 illustrate typical data obtained for the δ, calculated from the inclination of the line which appears vertical for various declinations introduced. In the figure, the declination measured is plotted on the ordinate, and the declination introduced by the geared unit, on the abscissa. It will be noted that the measured declination from the inclined line is twice that introduced. Clearly, then, cyclo-

TABLE 2.—*Typical Data* Showing a Cyclofusional Movement of the Eyes Due to the Compulsion to Fusion on a Horizontal Line When Declinations Are Introduced by Meridional Size Lenses*

Declination Introduced, Degrees (δ_u)	Inclination of Line, Degrees (ι)	Equivalent Declination (Computed), Degrees (δ_m)
+0.84	—40.7	—1.52
+0.67	—28.3	—0.99
+0.51	—20.0	—0.66
+0.34	—12.3	—0.39
+0.17	— 2.0	—0.06
0.00	+ 4.5	+0.14
0.00	+ 7.8	+0.25
—0.17	+17.4	+0.57
—0.34	+25.4	+0.85
—0.51	+33.7	+1.20
—0.67	+39.1	+1.46

* The values are the degrees through which a line must be inclined fore and aft in space to appear truly vertical (data obtained from K. N. O.).

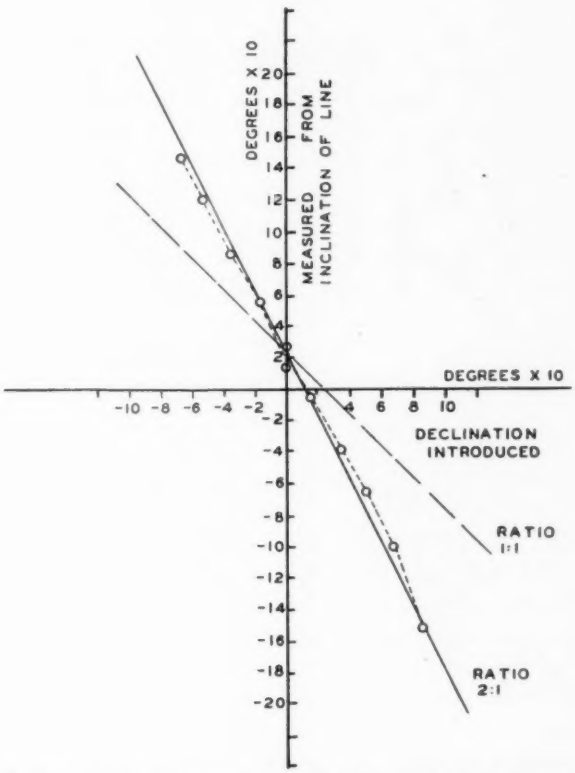

Fig. 6.—Typical data from the inclination of a vertical line in space adjusted for the apparent stereoscopic vertical when declinations between the retinal images of the two eyes are introduced by optical means. The 2 : 1 ratio indicates that cyclofusional movements have occurred which entirely eliminate the declination between the retinal images for a horizontal line.

fusional movements must have occurred to eliminate entirely the declination between the images of the horizontal line. However, when the central line appeared vertical there would be no declination between its images in the two eyes, and hence it would exert no antagonistic compulsion to fusion.

While interesting, this experiment does not tell what the cyclofusional movement would be on the vertical and the horizonal line when a declination on each is introduced by the geared unit, for, obviously, as the line is inclined to appear vertical in the experiment the compulsion to fuse the declination between its images decreases and the only compulsion is exerted by the horizontal line. One would anticipate, therefore, a 2:1 ratio between the declination measured and that indicated by the drum on the geared unit.

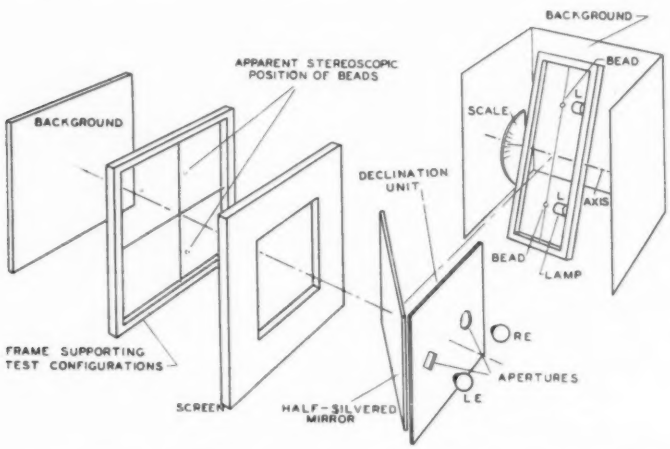

Fig. 7.—Perspective drawing of modified apparatus showing a bead device, by which the apparent stereoscopic vertical could be determined.

The problem, then, was to find a device which would permit one to establish the apparent stereoscopic vertical (stereovertical) in a given experiment without that device itself introducing a measurable compulsion to cyclofusional movements. It was found that two separated pearl beads on a black thread attached in the rotatable frame previously described might be used. However, even the black thread itself was visible in many positions of the frame, and this was found to exert a compulsion for a cyclofusional movement.

The apparatus was therefore enlarged, so that the beads would be seen by reflection in a half-silvered mirror set up in front of the declination unit (fig. 7). The beads were supported on a black thread attached to the top and bottom of a narrow wooden frame, which was pivoted so as to rotate about a horizontal axis at the level of the subject's eyes.

The distance of this frame was such that the images of the beads were seen stereoscopically at the same distance as the distance of the frame supporting the test elements of the apparatus. The beads were independently illuminated and seen against a black background. If the experiments were conducted in a half-darkened room, the thread supporting the beads could not be seen. As compared with most of the test configurations used, the beads themselves exerted only an insignificant compulsion for cyclofusional movements.

To reduce further a possible compulsion to fusion on the beads, a timing device was placed in the electrical circuit of the lamps so that the beads would be seen intermittently for only a second at a time, with a one second "off" interval. By means of a hand wheel and cords, the subject could adjust the inclination of the frame and therefore that of the beads. As before, the angle of inclination was taken as positive when the beads were inclined back (away) at the top, in order that the corresponding declinations of the images in the two eyes would be positive. The test configurations themselves (except where noted) were then fixed vertically in the central frame.

The procedure in a given experiment was simply to introduce a declination between the images of the two eyes by means of the geared unit [25] and to instruct the subject to turn the hand wheel to adjust the beads until they appeared vertical (or, what is equivalent in this case, equally distant from him). The actual inclination of the cord supporting the beads was then read from the scale attached to the frame. From this measurement the equivalent declination was then computed, as previously indicated.

The suitability and precision of the technic of using the beads in this modified apparatus are shown in three fundamental experiments. First, a single horizontal line only is used. The declination unit introduces equal declinations, though opposite in direction, in the vertical and the horizontal meridian. If no cyclofusional movement occurs to reduce or eliminate the declination of the images of the horizontal line, then the actual inclination of the beads should only be such as to offset the vertical declination introduced by the geared unit. If, however, a cyclofusional movement of the eyes does occur and eliminates the declination of the images of the horizontal line, then the actual inclination of the beads should be such as to offset twice the declination between the images for the vertical meridian. The results, as shown in table 3 and figure 8, show that this cyclofusional movement has occurred to the full extent.

25. It was often noted that if one observed a configuration when a declination had been introduced the subjective impression was that the vertical contours were vertical. But when the beads were then adjusted so that they appeared vertical, these contours appeared definitely inclined.

In the figure, the declination angle introduced by the geared unit is plotted on the abscissa, while along the axis of ordinates are plotted the corresponding declinations between the images of the two eyes

TABLE 3.—*Typical Set of Data Showing the Measured Vertical Declination Between the Images of the Two Eyes as Measured by the Inclination at Which Two Separated Beads Were Set so as to Appear Vertical When Declinations Were Introduced Between the Images* *

	Horizontal Line Only		Vertical Line Only		Oblique Cross Only	
Declination Introduced, Degrees (δ_a)	Inclination of Beads, Degrees	Corresponding Declination, Degrees (δ_b)	Inclination of Beads, Degrees	Corresponding Declination, Degrees (δ_b)	Inclination of Beads, Degrees	Corresponding Declination, Degrees (δ_b)
+0.80	−42.1 ± 1.7	−1.56	−2.2 ± 0.1	−0.06	−25.5 ± 0.8	−0.78
+0.60	−31.6 ± 0.7	−1.06	−1.7 ± 0.2	−0.04	−18.7 ± 0.7	−0.55
+0.40	−21.7 ± 1.1	−0.67	−1.9	−0.05	−11.3 ± 1.1	−0.33
+0.20	−10.9 ± 1.2	−0.32	−2.3 ± 0.5	−0.06	− 5.2 ± 0.3	−0.15
−0.20	+13.1 ± 0.4	+0.39	−1.7 ± 0.1	−0.04	+ 5.9 ± 0.1	+0.17
−0.40	+21.2 ± 0.8	+0.65	+1.5 ± 1.3	+0.04	+11.6 ± 2.0	+0.33
−0.60	+34.2 ± 1.1	+1.17	+3.0 ± 2.2	+0.09	+20.3 ± 0.5	+0.61
−0.80	+41.3 ± 0.7	+1.52	+6.1 ± 1.1	+0.17	−25.9 ± 0.6	+0.79

* Data for K. N. O.; visual distance, 2.2 meters.

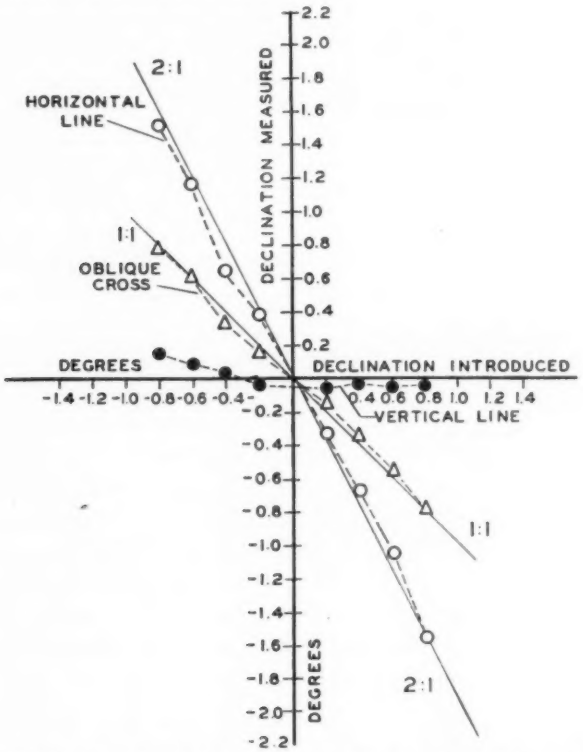

Fig. 8.—Typical results obtained for the three fundamental experiments using the beads as a means of determining the spatial inclination for the apparent stereoscopic vertical.

determined from the actual inclination of the beads for which they appeared vertical.

Second, a vertical cord only is used as the test configuration. Again, the beads, which are seen a little to one side of the line, are adjusted by the subject for the apparent vertical. The actual inclination of the beads will be different, depending on whether or not a cyclofusional movement has occurred. If no fusional movement has taken place, the line should appear inclined in space because of the vertical declination that has been introduced. The inclination of the beads should then be such as to offset the vertical declination introduced. On the other hand, if there is a cyclofusional movement such as to eliminate

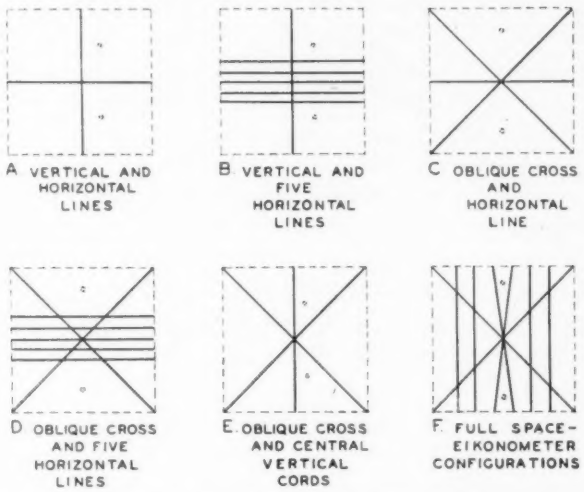
A VERTICAL AND HORIZONTAL LINES
B VERTICAL AND FIVE HORIZONTAL LINES
C OBLIQUE CROSS AND HORIZONTAL LINE
D OBLIQUE CROSS AND FIVE HORIZONTAL LINES
E OBLIQUE CROSS AND CENTRAL VERTICAL CORDS
F FULL SPACE-EIKONOMETER CONFIGURATIONS

Fig. 9.—Configurations used as binocular fusional stimuli for studying cyclofusional movements in response to declinations introduced between the images of the two eyes by optical means. The small circles of interrupted lines indicate the approximate position of images of beads as seen by the subject.

A consists of a vertical and a horizontal line; *B*, of a vertical and five horizontal lines; *C*, of an oblique cross and a horizontal line; *D*, of an oblique cross and five horizontal lines; *E*, of an oblique cross and a central vertical cord, and *F*, full space eikonometer configurations.

entirely the vertical declination introduced, the line should appear vertical, and the actual inclination of the beads should be zero. The latter is shown to be the case, except for a suggestion that when negative declinations are introduced the cyclofusional movement is not quite complete.

Third, an oblique cross consisting of white cords attached to the corners of the frame is used as the test configuration. With this configuration, a 1:1 ratio would be expected between the measured δ_b from the setting of the beads and the vertical declination δ_u introduced, because the geared unit does not itself affect the apparent orientation

of the oblique cross. As shown by table 3 and figure 8, the measured declinations associated with the beads are substantially equal to the declinations introduced.

These results indicate that with a single stimulus for cyclofusional movement, that movement occurs practically completely in the interest of single binocular vision and, therefore, for the purpose of making the retinal images in the two eyes fall as nearly as possible on meridians corresponding to the stereoscopic vertical.

CYCLOFUSIONAL MOVEMENTS

More important now is the answer to the question how the eyes respond to stimuli for fusional movements which are antagonistic. The studies described in the following section seek to answer that question.

Vertical and Horiztonal Lines.—This configuration consists of vertical and horizontal strings attached to the sides of the central frame (fig. 9 *A*). As already pointed out, a setting of the geared unit introduces equal but opposite declination between the images of the two eyes for the vertical and the horizontal meridian (fig. 2). Each of the elements of this configuration, therefore, provides a stimulus for a cyclofusional movement in an opposite direction. If each exerted the same compulsion, no torsion would result. However, in general, it was found that there was a cyclofusional movement in the direction to decrease the declination between the images of the vertical element.

The inclination of the beads will always provide the measure for the resultant declination of the images of the vertical elements. Hence, if a vertical declination of δ_u degrees is introduced by the geared unit, and subsequently a cyclofusional movement of τ degrees occurs, the resultant vertical declination between the images would be $(\delta_u - \tau)$. Here, τ is taken as positive for an excyclotorsion and as negative for an incyclotorsion. The beads will then have to be inclined in space if they are to appear vertical, so that the vertical declination they introduce, δ_b, will offset the resultant declination. One has, then, $\delta_b = -(\delta_u - \tau)$, and hence the cyclotorsion τ between the eyes will be $\tau = \delta_b + \delta_u$.

In table 4 and figure 10, typical data for this configuration are given. The one set of data is for the single vertical and horizontal strings, showing that cyclofusional movements to the extent of 60 per cent have occurred to correct the vertical declination. If more horizontal lines with greater contrast, such as white rope, replace the single horizontal cord (fig. 9 *B*), the cyclofusional movement is significantly less, showing that the compulsion for fusion on the horizontal strings has now been increased. However, the compulsion from the vertical strings is still strong enough to cause an actual cyclofusional movement.

Attempts were made to influence the degree of cyclofusional movements by having the subject concentrate his attention on the vertical or the horizontal elements. However, no significant differences in the results were found in this case.

TABLE 4.—*Typical Data Showing Degree of Cyclofusional Movements Associated with Configurations of Vertical and Horizontal Lines When Equal but Opposite Declinations Are Introduced Between the Images of Those Lines* *

	Vertical and Horizontal Cord			Vertical Cord with Five Horizontal Ropes		
Declination Introduced, Degrees (δ_u)	Inclination of Beads, Degrees (ι)	Corresponding Declinations, Degrees (δ_b)	Total Cyclotorsion of Eyes, Degrees (τ)	Inclination of Beads, Degrees (ι)	Corresponding Declinations, Degrees (δ_b)	Total Cyclotorsion of Eyes, Degrees (τ)
+0.80	—15.1	—0.45	+0.35	—15.4	—0.46	+0.34
+0.60	— 7.9	—0.24	+0.46	—12.7	—0.38	+0.22
+0.40	— 5.5	—0.17	+0.23	— 7.8	—0.23	+0.17
+0.20	— 2.8	—0.09	+0.11	— 4.9	—0.14	+0.06
—0.20	+ 0.1	+0.01	—0.19	+ 3.2	+0.10	—0.10
—0.40	+ 3.2	+0.12	—0.28	+ 8.2	+0.24	—0.16
—0.60	+ 8.9	+0.26	—0.34	+16.1	+0.48	—0.12
—0.80	+12.4	+0.36	—0.44	+20.3	+0.62	—0.18

* Data for K. N. O.

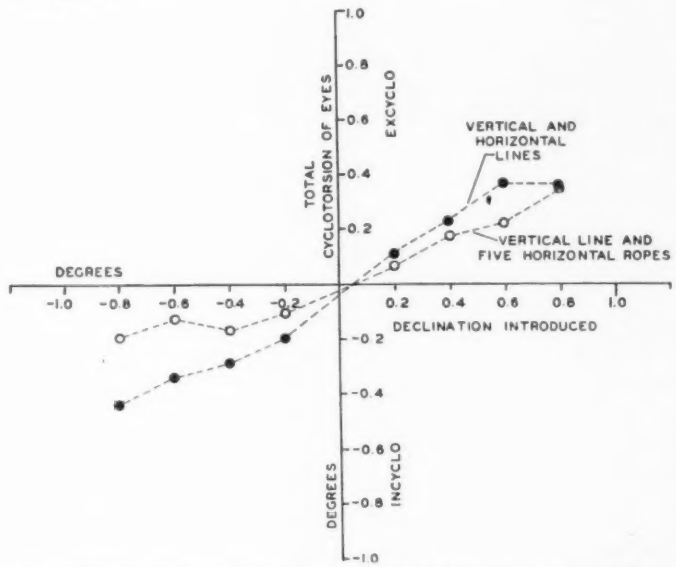

Fig. 10.—Results which show that the compulsion for a cyclofusional movement is greater for declinations between images of vertical lines than for declinations between images of horizontal lines of the same weight. When more horizontal contours are added, this cyclofusional movement is reduced.

There was other evidence that the compulsion for a cyclofusional movement exerted by the vertical contours was not only stronger than that exerted by the horizontal but much faster. A series of settings

of the beads made at intervals of about fifteen seconds showed that in the beginning the cyclotorsion was actually greater for the vertical line (almost complete at times) and that as the settings were continued the magnitude of the cyclotorsion in that direction decreased; i. e., a cyclofusional movement toward the horizontal increased, finally reaching a stable value. Even these values might vary somewhat over a prolonged period of observation.

This phenomenon of a stronger and faster compulsion to fusion caused by declinations of the images of vertical contours than by declinations of images of horizontal contours, in spite of stereopsis, is noteworthy not only for its own sake but because it is not consistent with accepted notions, at least regarding fusional movements in the visual plane. There the evidence was that contours whose retinal images were disparate exerted involuntary compulsions to fusion only when not seen in stereoscopic depth.

A Horizontal Element and an Oblique Cross.—When an oblique cross consisting of cords stretched between the corners of the frame is substituted for the vertical line used in (fig. 9 *C*) in the preceding experiment, the stimulus for a cyclofusional movement can arise only from the horizontal contour (since the cross is unaffected by the geared unit). The settings of the beads in this experiment proved unsually difficult as compared with the previous experiments because the great subjective uncertainty of each setting proved disturbing, and even frustrating.

If a cyclofusional movement does occur to decrease or eliminate the declination between the image of the horizontal contours, then the oblique cross should appear inclined in space. The magnitude of this inclination, ι_c, is related to the amount of cyclotorsion, τ, by [19e]

$$\tan \iota_c = -\frac{b}{a} \tan \tau$$

where, as before, b is the visual distance and $2a$ is the interpupillary separation; b being large as compared with a, τ will be positive for an excyclotorsion and negative for an incyclotorsion of the eyes. The inclination, ι_c, will be positive when the top of the cross appears farther away and negative when it appears nearer. It is clear that this inclination is roughly twice that of a vertical line for the equivalent declination between the retinal images.

In this experiment the beads could be adjusted for two criteria: (1) the apparent vertical and (2) the same apparent inclination of the plane of the cross. The cyclotorsion can be determined from either measurement. As previously outlined, from the inclination of the beads for the apparent vertical, the cyclotorsion would be given by $\tau = \delta_u + \delta_b$. When the beads are adjusted so that they have the same apparent inclination, ι_c, as has the cross, one can write (from

equations 1 and 3) that if δ_{bc} denotes the declination corresponding to the inclination of the beads

$$\tan \iota_c = -\frac{b}{a}\tan \tau = \frac{b}{2a}(\tan \delta_u - \tan \tau + \tan \delta_{bc}).$$

Remembering that the angles δ and τ are small, one obtains for the cyclotorsion, $\tau = -(\delta + \delta_{bc})$. From these two formulas, it is clear that $\delta_u = -(\delta_b + \delta_{bc})$. This last relation provides a check on the consistency of the data when both criteria are used, and the values obtained will indicate the degree to which a change in the cyclotorsion has occurred between the two parts of the experiment according to the two criteria.

TABLE 5.—*Data Showing Increased Cyclotorsional Movements Associated with Increased Number of Horizontal Contours* *

Declination Introduced, Degrees	Setting Beads for Apparent Vertical: Inclination, Degrees	Setting Beads for Apparent Vertical: Declination, Degrees	Setting Beads for Apparent Vertical: Cyclotorsion, Degrees	Setting Beads for Same Apparent Inclination as That of Cross: Inclination, Degrees	Setting Beads for Same Apparent Inclination as That of Cross: Declination, Degrees	Setting Beads for Same Apparent Inclination as That of Cross: Cyclotorsion, Degrees	Consistency Check, Degrees	Average Cyclotorsion, Degrees
(δ_u)	(ι_v)	(δ_{bv})	$\tau = -(\delta_u+\delta_{bv})$	(ι_v)	(δ_{bc})	$\tau = -(\delta_u+\delta_{bc})$	$-\frac{1}{2}(\delta_{bv}+\delta_{bc}) = \delta_u$	(τ)
			I. Oblique Cross and Horizontal Line					
+0.80	−23.9	−0.72	+0.08	−23.1	−0.70	−0.10	+0.71	−0.01
+0.60	−20.8	−0.62	−0.02	−14.9	−0.44	−0.16	+0.53	−0.09
+0.40	−18.2	−0.54	−0.14	−13.3	−0.39	−0.01	+0.46	−0.07
+0.20	−10.4	−0.30	−0.10	− 3.8	−0.11	−0.09	+0.20	−0.09
−0.20	+ 6.6	+0.19	−0.01	+10.3	+0.29	+0.09	−0.24	+0.04
−0.40	+17.2	+0.50	+0.10	+14.7	+0.43	−0.03	−0.47	+0.03
−0.60	+20.0	+0.60	0.0	+20.8	+0.62	−0.02	−0.61	−0.01
−0.80	+24.4	+0.74	−0.06	+27.0	+0.83	−0.03	−0.78	−0.05
			II. Oblique Cross and Five Horizontal Lines					
+0.80	−38.0	−1.31	−0.51	− 3.0	−0.09	−0.71	+0.70	−0.61
+0.60	−31.4	−1.0	−0.40	− 3.7	−0.11	−0.49	+0.56	−0.45
+0.40	−23.7	−0.70	−0.30	− 4.0	−0.12	−0.18	+0.41	−0.24
+0.20	−15.7	−0.46	−0.26	−0.35	−0.01	−0.19	+0.23	−0.22
−0.20	+13.7	+0.40	+0.20	− 0.1	−0.01	+0.21	−0.20	+0.20
−0.40	+22.6	+0.68	+0.28	− 2.0	−0.06	+0.46	−0.37	+0.37
−0.60	+26.3	+0.81	+0.21	+ 3.6	+0.10	+0.50	−0.46	+0.45
−0.80	+27.0	+0.83	+0.03	+ 8.0	+0.24	+0.56	−0.53	+0.29

* Data on V. J. E.

Table 5 gives the typical data for 1 subject. These are also illustrated in figure 11. For this subject, substantially no significant cyclofusional movement occurred in any part of the experiment with the oblique cross and the horizontal line. Thus, it is clear in this case that the compulsion for a cyclofusional movement is not sufficient to counterbalance the compulsions that would be introduced by the disparate images of the lines of the oblique cross.

If, however, five horizontal heavy white ropes are substituted for the single horizontal cord (fig. 9 *D*), significantly large cyclofusional movements do occur which for the small declinations introduced are sufficient to eliminate completely the declinations of the images of the horizontal elements. Thus, as soon as the number and contrast of

the horizontal contours are increased, the compulsion arising from the declinations of these contours becomes great enough to offset entirely the opposing compulsions that arise from the oblique cross, and then a torsion takes place.

A Vertical Element and an Oblique Cross.—Consider, now, an oblique cross in combination with vertical elements in the plane of the cross. These vertical elements may consist of a single vertical cord (fig. 9*E*), two separated vertical cords or two cords crossed at a very acute angle, as shown in the center of figure 9*F*. When the geared unit is now used to introduce declinations, the cross itself will not be affected, but declinations will be introduced between the images of the vertical elements. The extent to which a cyclofusional movement will now occur depends on the relative compulsions of the vertical contours as opposed to those of the oblique cross. With the procedure

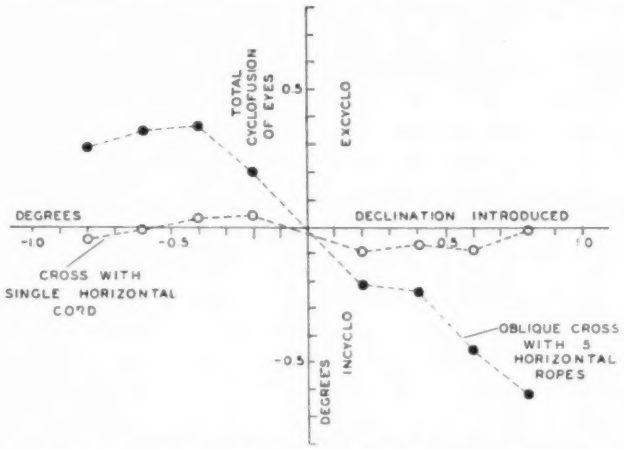

Fig. 11.—Results which show that only when the number of horizontal contours is increased will the compulsion for a cyclofusional movement offset the stabilizing effect of an oblique cross.

previously outlined, data were obtained according to the two criteria. Table 6 gives typical results, which are also illustrated in figure 12. These results show that cyclofusional movements do occur in every case, and their magnitude is about the same for any one of the types of vertical elements.

However, if the central vertical elements are placed in front of the plane of the cross, so that their images, as compared with the images of the cross, now have horizontal disparities, the cyclofusional movements are greatly reduced. In the experiment in which the two vertical cords are 40 cm. in front of the cross, practically no cyclotorsion takes place. Typical data are also shown in figure 12. Thus, as might be anticipated, the compulsion for cyclofusional movements

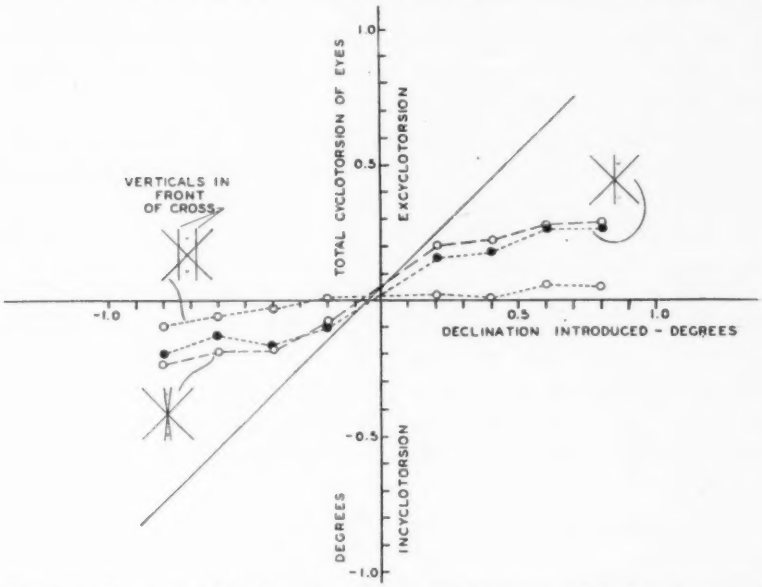

Fig. 12.—Results which show that the compulsion for cyclofusional movements from images of vertical contours is greater than that from the oblique cross. When horizontal disparities are introduced between the images of vertical contours, the compulsion of those images to cyclofusional movements decreases.

TABLE 6.—*Data Showing Degree of Cyclofusional Movements Associated with Vertical Contours Against the Stabilizing Contours of the Oblique Cross* *

Declination Introduced, Degrees	Setting Beads for Apparent Vertical			Setting Beads for Same Apparent Inclination as That of Cross			Consistency Check, Degrees	Average Cyclotorsion, Degrees
	Inclination, Degrees	Declination, Degrees	Cyclotorsion, Degrees	Inclination, Degrees	Declination, Degrees	Cyclotorsion, Degrees	..... $-\frac{1}{2}(\delta_{bv}+\delta_{bc})$	
(δ_u)	(ι_v)	(δ_{bv})	(τ)	(ι_v)	(δ_{bc})	(τ)	($=\delta_{bu}$)	(τ)
I. Oblique Cross and Single Vertical Cord in Plane of Cross								
+0.80	−16.6	−0.49	+0.31	−31.8	−1.01	+0.21	+0.75	+0.26
+0.60	−10.7	−0.31	+0.29	−27.9	−0.86	+0.26	+0.58	+0.27
+0.40	− 7.0	−0.20	+0.20	−18.8	−0.55	+0.15	+0.38	+0.18
+0.20	− 2.5	−0.07	+0.13	−13.8	−0.40	+0.20	+0.23	+0.16
−0.20	+ 4.3	−0.13	−0.07	+11.7	+0.34	−0.14	−0.23	−0.10
−0.40	+ 6.9	+0.20	−0.20	+18.4	+0.54	−0.14	−0.37	−0.17
−0.60	+15.1	+0.45	−0.15	+23.9	+0.72	−0.12	−0.63	−0.13
−0.80	+17.3	+0.51	−0.29	+29.5	+0.92	−0.12	−0.71	−0.20
II. Oblique Cross and Two Crossed Central Cords in Plane of Cross								
+0.80	−13.1	−0.38	+0.42	−29.9	−0.94	+0.14	+0.76	+0.28
+0.60	− 9.8	−0.28	+0.32	−27.0	−0.83	+0.23	+0.56	+0.27
+0.40	− 4.7	−0.14	+0.26	−19.5	−0.58	+0.18	+0.36	+0.22
+0.20	− 2.3	−0.07	+0.13	−10.6	−0.47	+0.27	+0.27	+0.20
−0.20	+ 6.0	+0.17	−0.03	+11.9	+0.34	−0.14	+0.26	−0.08
−0.40	+ 9.2	+0.27	−0.13	+17.6	+0.52	−0.12	+0.39	−0.18
−0.60	+11.1	+0.33	−0.27	+23.9	+0.72	−0.12	+0.53	−0.19
−0.80	+13.2	+0.38	−0.42	+28.1	+0.87	−0.07	+0.63	−0.24
III. Oblique Cross and Two Vertical Cords in Front of Plane of Cross								
+0.80	−26.2	−0.81	−0.01	−29.4	−0.91	+0.11	+0.96	+0.05
+0.60	−21.5	−0.64	−0.04	−25.8	−0.78	+0.18	+0.71	+0.06
+0.40	−14.5	−0.42	−0.02	−14.9	−0.43	+0.03	+0.42	+0.01
+0.20	− 6.5	−0.18	+0.02	− 6.6	−0.17	+0.03	+0.18	+0.02
−0.20	+ 6.1	+0.18	−0.02	+ 4.3	+0.13	+0.07	−0.16	+0.02
−0.40	+11.6	+0.34	−0.06	+17.5	+0.52	−0.12	−0.43	−0.03
−0.60	+17.2	+0.50	−0.10	+20.9	+0.62	−0.02	−0.56	−0.06
−0.80	+24.7	+0.75	−0.05	+30.5	+0.96	−0.16	−0.85	−0.10

* Data for V. J. E.

resulting from declinations of the images of vertical contours is reduced if horizontal disparities are also introduced between their images in the two eyes.

On the other hand, if pairs of vertical cords are placed both before and behind the plane of the cross (as in the case of the space eikonometer), cyclofusional movements will occur.

In figure 12 are also illustrated the typical results of the degree of cyclofusional movements that occur with the complete configuration of test elements as used in the space eikonometer (cf. fig. 9 *F*). It would appear that these movements are not much greater with the four vertical cords than are those found with the central vertical elements in the plane of the cross.

Vertical and Inclined Contours.—Cyclofusional movements also occur when both vertical and inclined contours only are present in the field of view.

If the outer two of three vertical lines (in the objective frontoparallel plane) in space are inclined with their tops nearer the observer and the entire binocular visual field is restricted to these lines, it will be seen that the central line, instead of appearing vertical, as it is, appears inclined somewhat back at the top. Werner [26] described this phenomenon as observed in a stereoscope and designated it a "binocular depth contrast" phenomenon.

Within the central frame of the apparatus a separate square frame was fixed so that it could be rotated about a horizontal axis and could be adjusted for any angle of inclination. Within both the fixed and the movable frame various configurations of cords could be fastened. Six configurations were used: (1) two separated cords, one of which was vertical and the other could be inclined; (2) one central vertical cord and two outer cords which could be inclined; (3) the same configuration as that designated in (2) except that a horizontal cord was added; (4) two vertical cords and a central cord which could be inclined; (5) a central vertical cord and eight cords, four on a side, which could be equally inclined, and (6) eight vertical cords and one cord which could be inclined. The geared unit was set at zero and was not used. Obviously, the purpose of these different configurations was to get various degrees and types of compulsions for cyclofusional movements. Throughout the experiments the beads were used to determine that inclination which corresponded to the criterion of the subjective vertical. The inclination of the beads when the two appeared vertical would give a direct measure of the degree of cyclotorsion the eyes had undergone, since the geared unit was not used.

26. Werner, H.: Binocular Depth Contrast and the Conditions of the Binocular Visual Field, Am. J. Psychol. **51**:489-497, 1938.

Table 7 gives the data for 1 subject. The data are also illustrated graphically in figure 13. A study of the data thus presented shows clearly that a cyclofusional movement generally takes place except when the number of contours which could give rise to antagonistic compulsions are greatly increased.

TABLE 7.—*Typical Data Showing Existence of Cyclofusional Movements in Various Combinations of Vertical and Inclined Lines* *

Inclination of Elements		Two Lines, One Inclined		Three Lines, Outer Inclined		Three Lines, Inner Inclined		Nine Lines, All But Center Inclined		Nine Lines, Only Center Inclined	
(ι)	(δ)	(ι_b)	(δ_b)	(ι_b)	(δ_b)	(ι_b)	(δ_b)	(ι_b)	(δ_b)	(ι_b)	(δ_b)
+40	+1.46	+20.9	+0.63	+20.2	+0.94	+2.1	+0.06	+28.8	+0.92	—0.1	—0.1
+30	+0.97	+16.8	+0.50	+16.6	+0.50	+2.0	+0.06	+19.3	+0.57	—1.7	—0.06
+20	+0.61	+ 9.7	+0.29	+13.6	+0.40	+1.5	+0.05	+13.0	+0.38	—1.1	—0.03
+10	+0.30	+ 5.1	+0.15	+ 4.9	+0.14	+0.3	+0.01	+ 5.1	+0.15	—0.3	—0.01
—10	—0.30	— 3.9	—0.12	—10.2	—0.30	—2.4	—0.07	—11.1	—0.33	—1.7	—0.05
—20	—0.61	— 6.4	—0.18	—13.4	—0.40	—1.6	—0.05	—15.9	—0.47	—2.5	—0.07
—30	—0.97	— 8.9	—0.26	—17.5	—0.53	—2.8	—0.08	—19.7	—0.60	—2.7	—0.08
—40	—1.46	—10.0	—0.30	—21.2	—0.65	—2.9	—0.08	.....	.....	—3.7	—0.1

* The declination of the images in the two eyes (δ_b) corresponding to the inclination of the beads when these appeared vertical is equal to cyclotorsion that has occurred (data for K.NO.).

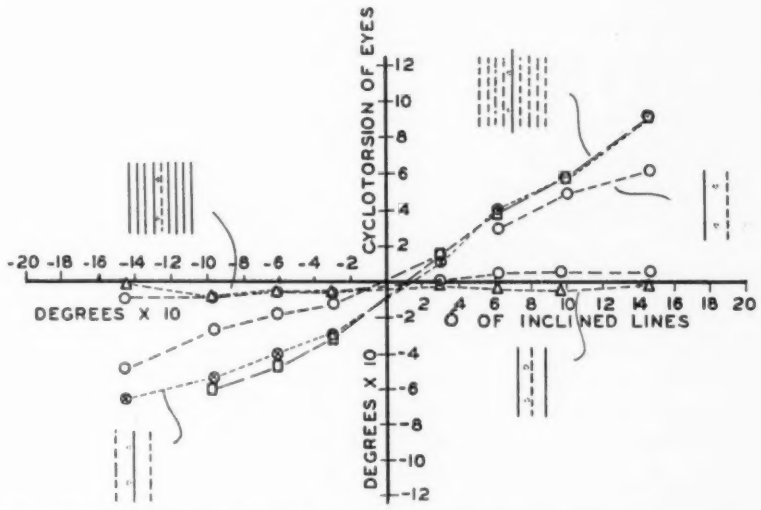

Fig. 13.—Experiments which show that when a set of vertical contours and a set of inclined contours are present in the visual field, a cyclofusional movement occurs to compromise the resulting declinations of the images of the two sets. In the inserts, the solid lines indicate those contours that remain vertical; the dash lines, those that are inclined in space.

These experiments, in general, in which a series of parallel lines are inclined in space, are not wholly satisfactory because of perspective, which makes lines appear to converge at a distance, and this con-

vergence introduces a confusing empiric factor. There is no simple optical means without the use of other mirrors, which can be employed to overcome this situation. However, it appears that this factor has not seriously affected the results presented here.

Werner ascribed the phenomenon to "a change in the correspondence within the particular visual field." The nature of this "change in correspondence" is not clear, but in view of his other experiments reported in the same article a sensorial change is implied. Our experiments here make clear that there has been no change in the sensorial (or anatomic) correspondence between the retinas of the two eyes, but only a change in cyclotorsional positions of the eyes. This change might, however, be interpreted as a change of correspondence if that correspondence is related to external points in space the images of which fall on corresponding meridians.

COMMENT

The problem of cyclofusional amplitudes has been avoided in all the experiments described in this paper, partly because the optical-mechanical difficulties would be greatly increased if they were to be thoroughly investigated and also because these amplitudes are known to be so variable and so subject to training that the number of experiments would be interminable. Furthermore, there is a question whether any useful information beyond that found could be obtained from such data.

It would, of course, have been desirable to set up a suitable telescope, or similar device, to detect and to measure the actual cyclotorsional movements of the eyes in our experiments, as had been done by Brecher.[13] The magnitude of the movements here, however, is small; and when it is divided between the two eyes, the value for each is so small as to preclude practically such objective measurements. The precision to which Brecher could measure the cyclorotations was of the order of ½ to 1 degree, which, obviously, is not accurate enough here. To observe the linear movements of blood vessels near the limbus would also demand great precision, since a cyclorotation of the eye of 1 degree would give a displacement of only about 0.2 mm.

Under the controlled conditions described here, in which empiric factors and motives for depth perception are eliminated, in so far as possible, it is demonstrable that the eyes are capable of making cyclofusional movements of great precision. Thus, a standard deviation of ± 0.07 degree of declination was not unusual under optimal conditions. Such precision should be compared with stereoscopic thresholds of 5 seconds of arc, a precision which is significant in view of the small involuntary movements of the eyes (physiologic nystagmus) that are constantly present. In the case of stereoscopic thresholds, however,

these ocular movements may even aid the stereoscopic perception.[27] In the experiments described here, the cyclofusional movements as measured through the stereoscopic perception of declinations between the images in the two eyes might not be so aided, except on the basis, which has been implied,[28] that these involuntary rotary movements always take place equally and in the same direction in the two eyes.

Under our well controlled conditions, it has been shown that the eyes respond to stimuli from contours in either the horizontal or the vertical meridian and that even separated points of light, if disparate in the sense of declination, can provide sufficient stimuli for an actual cyclofusional movement. The unsatisfactory responses previously found in the use of vertical lines can be attributed to their employment for determining cyclofusional amplitudes where doubling is the criterion.

The results here show incontestably that the compulsion to cyclofusional movements arising from contours in the vertical or near vertical meridians is much greater than that from contours in other meridians, especially the horizontal. This difference which is found between the vertical and other meridians is surprising and difficult to explain satisfactorily.

However, the declinations between the images of vertical or near vertical contours also result in a stereoscopic perception of depth, while those of horizontal contours cannot. That the processes of stereoscopic vision are rapid (of the order of several hundredths of a second, according to Langlands [29]) while the cyclofusional processes with horizontal contours are slow (of the order of one-half second, according to Verhoeff [11d]) may hold the key to the explanation. Certainly, there exists a basis for suggesting that, in general, stereoscopic perception results from the compulsion to fuse disparate images, as Fleischer,[30] for example, has done. In this sense, the processes of stereoscopic perception and those of the compulsion for fusional movements are interrelated and concomitant. In that case, the cyclofusional movements compelled by the declinations of the images of vertical contours should be faster than those produced by the horizontal contours, and in being faster they accomplish the cyclotorsion before the compulsions from the horizontal contours can get under way.

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29. Langlands, N. M. S.: Experiments in Binocular Vision, Tr. Optic. Soc. London **28**:45-82, 1926.

30. Fleischer, E.: Die Querdisparation als physiologische Grundlage des binokularen Tiefensehens, Ztschr. f. Psychol. **147**:65-132, 1939.

The difference between the compulsions to fusion arising from vertical contours and those arising from horizontal contours cannot be associated with a sensorial difference in the perception of direction. It has been shown that lines can be set for the apparent vertical or horizontal meridians with considerable precisions, with no significant difference between the two.[31] However, this precision is much poorer for oblique contours.[32] The results described here show that the cyclofusional movements are roughly proportional to the declinations introduced. This would not be true when the declinations approach the limits of the cyclofusional amplitudes, where the amount of cyclofusional movement would be affected by cyclophorias and cyclotropias.

Clearly, the degree of cyclofusional movement varies not only with the configuration in the binocular field of view but with the contrast and relative weights of antagonistic declinations. This is to be expected on the basis of earlier investigations on the problem. Moreover, horizontal disparities between the images decrease the compulsion for cyclofusional movements. This may also be expected.

The results of these experiments explain satisfactorily the phenomenon of depth contrast of Werner. Likewise is explained the phenomenon in the space eikonometer, in which a meridional size lens at an oblique axis placed before the eye causes the oblique cross to appear inclined in space whereas the vertical plumb lines appear inclined only slightly or not at all, when according to geometric principles the reverse should be true.

In concluding this discussion, certain psychologic contrast effects should be mentioned. Hofmann and Bielschowsky [33] showed that a background of inclined contours affected one's conception of the meridian of the subjective vertical (not the stereoscopic vertical, but the vertical in the frontoparallel plane). The experiments of Vernon [34] and of Gibson [35] showed also that a prolonged observation of an inclined line (right or left) subsequently caused a vertical or horizontal line to appear inclined in the opposite direction. These effects are considered to be the result of experimental adaptive processes and are not concerned at all with the position of the eyes. However, all these observations should be considered in the light of the results of Noji [15]

31. Peirce, B. O.: The Perception of Horizontal and of Vertical Lines, Science **10**:425-430, 1899.

32. Hofmann,[17] p. 599.

33. Hofmann, F. B., and Bielschowsky, A.: Ueber die Einstellung der scheinbaren Horizontalen und Vertikalen bei Betrachtung eines von schrägen Konturen erfüllten Gesichtsfeldes, Arch. f. d. ges. Physiol. **126**:453-475, 1909.

34. Vernon, M. D.: The Perception of Inclined Lines, Brit. J. Psychol. **25**: 186-196, 1934.

35. Gibson, J. J.: Adaptation, After-Effect and Contrast in the Perception of Tilted Lines, J. Exper. Psychol. **20**:553-569, 1937.

and Brecher,[13] which certainly suggest that cyclotorsions can, under certain conditions, follow the influence of external stimuli. The famous case of Sachs and Meller [36] is often cited to show that the subjective vertical can be adapted to new retinal meridians in the case of pronounced cyclotropia, possibly in the same sense that an anomalous "correspondence" can develop in a case of squint. None of these adaptive experiments has been performed for the stereoscopic vertical, though Gibson believes the same type of phenomena will be found there.

While these problems are outside the scope of this paper, the results would seem to imply that the retinal meridians which correspond to the subjective verticals are variable and subject to previous experience. The crux of this problem is whether the retinal meridians corresponding to the subjective stereoscopic vertical can be the same meridians as those of the monocular subjective vertical. Certainly, the experiments described in this paper, in which the visual plane of the observer is horizontal, suggest that the subjective stereoscopic vertical agrees accurately with the objective vertical. The angle V (of von Helmholtz, Volkman, and others) between the meridians of the apparent subjective verticals of the two eyes, if maintained in binocular vision, would make this result impossible. It is probable, however, that the measurements of this angle, like the majority of those dealing with torsions of the eyes with convergence and with elevation and depression of the eyes, are made with targets which permit the eyes to slide into a cyclophoric position.

The results of the experiments described here would provide evidence for the discussion of Hering's [5] theory concerning enforced cyclofusional movements, to the effect that the eyes can make adjustments which tend to keep the images of vertical contours in space on the retinal meridians for the stereoscopic subjective vertical, irrespective of the movements of the eyes. These cyclofusional movements probably occur, however, in any complex visual field where certain contours are inclined fore and aft with respect to the visual plane, in an effort to compromise the disparities in the interest of a single binocular vision.

STATISTICAL STUDY BASED ON SUBJECTS WITH ASTIGMATISM AT OBLIQUE AXES

Several studies [37] at the Dartmouth Eye Institute have made it possible to obtain data with the space eikonometer on nearly 400 subjects who had astigmatism at oblique axes.

36. Sachs, M., and Meller, J.: Ueber einige eigentümliche Lokalisationsphänomene in einem Falle von hochgradiger Netzhautinkongruenz, Arch. f. Ophth. **57**:1-23, 1904.

37. Ogle,[19b] Ogle and Madigan,[19c] Burian and Ogle.[19d]

It was pointed out that the correction of the astigmatism in these subjects would introduce meridional magnifications of the retinal images also at oblique axes and that associated with these magnification errors declinations of the retinal images of vertical (and horizontal) lines would exist. One could, if compensatory processes were not active, expect to find under controlled conditions an incorrect apparent inclination of vertical configurations. From the amount of this inclination it was hoped to find, by means of the space eikonometer, the magnitude of the declination error introduced by the corrected astigmatism.

In the space eikonometer, the test elements consisted of an oblique cross, a vertical line (or a central line configuration) through the center of this cross and two vertical plumb lines in front of and two behind the cross (cf. fig. 9*F*). If a declination error were present, the central elements should not appear to lie in the plane of the cross. The experience of subjects with normal eyes was that with meridional size lenses placed before the eyes at oblique axes the cross appeared inclined. By means of the geared unit a suitable declination could be introduced to cause the plane of the cross and the center vertical elements to appear in the same plane, which usually also appeared substantially vertical. The same procedure of measurement was followed for the subjects with astigmatism at oblique axes.

The measured declination error, δ_m, was shown [19c] to be correlated with the calculated declination error, δ_o, computed on the basis of the amount and the axes of the astigmatic correction, the corneal astigmatism and the optical dimensions of the correcting lenses. This correlation was evidence of the stable organization of the retinal elements of the two eyes, according to the theories of Hering. It was shown, however, that on the average the measured declination error was less than the computed declination error by nearly one half.

This difference was explained on several hypothetic bases, one of which was the possible existence of cyclotropias. Until the present studies had been made, the nature of this possibility was not clear. Now, inasmuch as the declination error associated with the aniseikonic errors at oblique axes would affect the images of the vertical elements but not those of the oblique cross, stimuli would be present for cyclofusional movements in the direction necessary to correct the declination between the images of the vertical lines. The cross would then appear inclined fore and aft in space. The declination introduced by the examiner using the geared unit to make the plane of the cross appear upright or to make the central vertical line appear to lie in the plane of the cross would measure the declination error as influenced by the degree of cyclotorsion present.

One would expect, however, that if the cyclofusional processes of the subject being tested were normal, as the correction for the true

declination error was introduced, the stimuli for the cyclofusional movement from the vertical elements would be reduced, so that in the end the true declination error would have been measured. However, if a residual cyclotropia remained, the true declination error could not be determined.

If one assumes that the calculated declination error, δ_o, was the correct and true declination error, then, when the geared unit introduces a declination, δ_m, to make the vertical element and the oblique cross appear in the same plane (that is, have the same inclination, ι_c) one can find, consequently, the theoretic cyclotorsion, τ_t, from

$$\tan \iota_c = -\frac{b}{a} \tan \tau_t = \frac{b}{2a} (\tan \delta_o - \tan \tau_t - \tan \delta_m)$$

whence

$$\tau_t = \delta_m - \delta_o$$

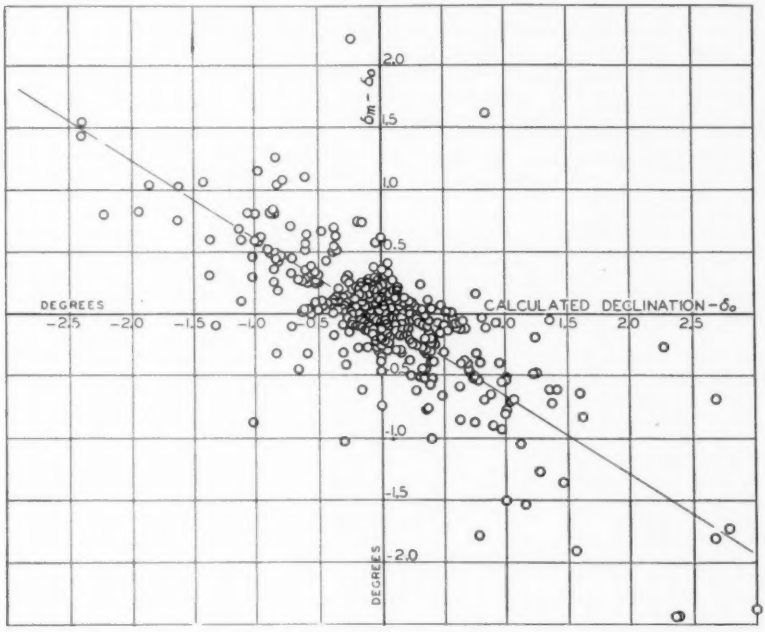

Fig. 14.—Scatter diagram of the data from 400 subjects with astigmatism at oblique axes in which the differences between the measured and the computed declination errors, $\delta_m - \delta_o$ are plotted against the computed declination error, δ_o. The difference $(\delta_m - \delta_o)$ is shown to indicate probably a disjunctive cyclotorsion of the eyes that exists at the time of measurement on the space eikonometer.

It was an easy matter, then, to caclculate τ_t with this formula from the data of the 400 cases.

According to the studies reported in this paper, the magnitude of the cyclofusional movement was roughly proportional to the declination introduced; hence, one might expect to find a correlation between the torsion, τ_t, found and the declination error, δ_o, calculated on the basis

of the corrected astigmatism. These values are shown in the scatter diagram in figure 14. Even a casual glance shows that a good correlation actually exists. A statistical analysis shows the Pearson coefficient of correlation to be 0.74, with a standard error of estimate of 0.36 degree, a value which certainly indicates significance. The degree to which these data show a lack of correlation may be due to other factors in the measurement of the aniseikonic error not connected with the correction of the astigmatic errors; but in spite of this the actual correlation found is significant. Further analysis of the data also shows that the distribution of τ_t for the 400 cases is quite normal.

The only explanation of this correlation is that the majority of these subjects with astigmatism at oblique axes had small residual cyclotropias, which in direction tended toward the elimination of the vertical declination errors that had been introduced by the correction of the astigmatism. These cyclotropias must have been the result of the tonic innervations for those movements that had been constantly present during the time the subject wore the spectacles. To repeat, this study suggests that these subjects maintain cyclotorsional positions of the eyes in order partially to correct the declinations of the images of vertical contours that arise from the meridional magnifications accompanying the correction of the astigmatic errors.

The results of this discussion account for much of the discrepancy betweeen the measured and the theoretic declination errors and add emphasis to the evidence of the previous paper [19c] that the physiologic organization of the two retinas is stable and must have been maintained independently of the origin of the astigmatism.

SUMMARY

A review of the literature shows that there is now agreement that the external muscles of the eyes can, in the interest of maintaining binocular single vision, cooperate to provide cyclotorsions about the visual axes, which themselves may remain fixed. These movements have been designated as psycho-optical reflex movements.

In this paper are discussed experiments utilizing stereoscopic methods of spatial localization, which show that these cyclofusional movements occur much more freely than was heretofore realized. In the main these movements take place with any change in the type and orientation of configurations in the visual field. When the contours make up complex spatial arrangements that provide stimuli for cyclofusional movements of different amounts and in different directions, the movements that take place tend to compromise the antagonistic compulsions resulting from those contours. However, it is shown that contours whose images in the two eyes are vertical or nearly vertical provide much stronger stimuli for cyclofusional movements than do

those from contours whose images are horizontal. The explanation of this fact probably lies in the relative speeds of stereoscopic vision and of ocular movements. The importance of the results of these experiments to certain psychologic and physiologic concepts is discussed.

A statistical study of the data obtained from 400 subjects having astigmatism at oblique axes is presented. The results suggest that the eyes of these subjects maintain cyclotorsional positions that partially correct the declinations of the images which, in turn, arise from the meridional magnifications accompanying the correction of the astigmatic errors.

The correlation found emphasizes the stability of the organization between the retinal elements of the two eyes, discussed in an earlier paper.

Dartmouth Eye Institute.

Clinical Notes

PENICILLIN IN TREATMENT OF ACUTE ENDOPHTHALMITIS

Report of a Case

S. WEIZENBLATT, M.D.
ASHEVILLE, N. C.

AS DEEP extraocular infections of the eye often lead to loss of vision or of an eyeball, every new antibacterial agent has promptly been tried in treatment of such infections. Soon after the bacteriostatic action of penicillin and its additional favorable characteristics, such as absence of toxicity and easy solubility, were established, experimental work by von Sallmann [1] and Leopold [2] on rabbit eyes showed that systemic or iontophoretic application of this drug did not lead to any detectable concentration in the lens or vitreous. Topical application of penicillin gave high concentrations of this drug in the anterior structures of the eye [3] and was effective in treatment of infections of the anterior part of the eye due to penicillin-sensitive organisms, but only direct injection of this drug into the lens or vitreous [4] was of benefit in experimental infections of the deeper parts of the eye with certain strains of Staphylococcus aureus, and then only if given within twelve hours after the inoculation.

Publications on the bacteriostatic action of penicillin in deeper parts of the eye are not many, and the results are not uniform.[5] As the concentration of penicillin in the aqueous of experimental animals was found to be higher than that in the aqueous of the human eye, results obtained by intravitreal injection of penicillin in rabbit eyes which had been inoculated with Staph. aureus or with pneumococcus need to be confirmed by further observation on the human eye. The following case may, therefore, be of interest.

1. von Sallmann, L.: Penicillin and Sulfadiazine in the Treatment of Experimental Intraocular Infection with Pneumococcus, Arch. Ophth. **30**:426 (Oct.) 1943. von Sallmann, L., and Meyer, K.: Penetration of Penicillin into the Eye, ibid. **31**:1 (Jan.) 1944.

2. Leopold, I. H.: Intravitreal Penetration of Penicillin and Penicillin Therapy of Infections of the Vitreous, Arch. Ophth. **33**:211 (March) 1945.

3. Struble, G. J., and Bellows, J. G.: Studies on the Distribution of Penicillin in the Eye, J. A. M. A. **125**:685 (July 8) 1944. Bellows, J. G.: Penicillin Therapy in Ocular Infection, Am. J. Ophth. **27**:1206 (Nov.) 1944.

4. Leopold.[2] von Sallmann, L.; Meyer, K., and Di Grandi, J.: Experimental Study on Penicillin Treatment of Ectogenous Infections of Vitreous, Arch. Ophth. **32**:179 (Sept.) 1944. Dunnington, J., and von Sallmann, L.: Penicillin Therapy in Ophthalmology, ibid. **32**:353 (Nov.) 1944.

5. von Sallmann, L.: Penicillin Therapy of Infections of the Vitreous, Arch. Ophth. **33**:455 (June) 1945.

REPORT OF CASE

A white man aged 49 was admitted to the hospital on April 13, 1945, because of a painful infection in his only eye. The previous history revealed that Elliott's trephination with peripheral iridectomy had been performed on both eyes for chronic glaucoma in 1940. Six months later he lost the right eye because of a late infection with Staph. aureus. Two infections occurred in the left eye in 1942, from which he recovered within four days. A third infection with Staphylococcus albus, in December 1943, resulted in purulent iritis, from which the eye recovered after oral treatment with sulfathiazole and injection of typhoid vaccine. Full vision was restored within four weeks.

Present History.—April 13: The patient awoke with severe pain in his left eye and greatly impaired vision. Examination showed a high degree of edema of the lids, severe conjunctivitis and yellow infiltration of the bleb. The anterior chamber was cloudy and the iris extremely hyperemic, with a small, fixed pupil. The fundus was seen only indistinctly; the patient saw fingers at 3 feet (91 cm.). Smear and culture revealed Staph. albus. Treatment consisted in instillation of atropine, application of hot compresses, intravenous injection of typhoid vaccine, instillation of penicillin drops (2,500 units per cubic centimeter) every hour and administration of sulfadiazine, 80 grains (5.2 Gm.) daily. Twelve hours later the pain in the eye had increased, and a hypopyon, measuring 2.5 mm., was present. Vision was limited to perception of hand movements before the eye. Penicillin, in 20,000 unit doses, was injected intramuscularly every four hours.

April 14: The condition of the eye was worse; the bleb was a solid plug of yellow infiltration, and the hypopyon was higher. The same treatment was continued; a second injection of typhoid vaccine resulted in a temperature of 105.6 F. The patient was confused and delirious.

April 15: The anterior chamber was clearer, the hypopyon smaller and the pupil well dilated; but a yellow reflex could be seen behind the lens in the temporal part of the vitreous. Projection was faulty. Two-tenths cubic centimeter of penicillin solution (2,500 units per cubic centimeter) was injected into the vitreous temporally and below after a preceding subconjunctival injection of procaine. Seven hours later the anterior part of the eye had cleared further.

April 16: About twenty-four hours after the intravitreal injection the cornea was steamy and hazy, the pupil dilated maximally and tension was plus 3. Use of atropine was discontinued.

April 17: The bleb was only slightly infiltrated; the cornea was clearer; the hypopyon was resorbed, and the iris was very hyperemic. Tension seemed normal. The vitreous was clearer.

April 18: Intramuscular injection of penicillin was discontinued. The patient's vision was improved.

April 20: The pain in the eye was worse. The cornea was hazy, with an irregular surface. The iris was less hyperemic. Tension was normal on palpation. A red reflex was obtained from the fundus. As the increased pain in the eye contrasted with the objective improvement of the endophthalmitis, the pathologic condition of the cornea was believed to be its cause and to be due to use of the penicillin drops, which was therefore discontinued.

The patient left the hospital fifteen days after the onset of the infection. At this time the eyeball showed a mixed injection; the bleb was very thin and transparent; the cornea and the anterior chamber were clear; the iris was hyperemic, and the pupil measured 6 mm. (after instillation of atropine). Some exudate and pigment were present on the anterior capsule of the lens. The lens

was clear. In the vitreous were numerous floating opacities, and adjoining the retina, at the site of the injection of penicillin, was a large oval, perlucid opacity, with a convex membrane anteriorly. Vision was 20/70.

In another month vision was 20/20. The perlucid opacity in the vitreous had shrunk and become a white, glistening, oval structure, seemingly fixed near the retina. The patient had repeated ruptures of the bleb, with absence of the anterior chamber, and for this a plastic operation was performed on the conjunctiva in October 1945.

A check-up in February 1946 revealed a normal condition of the anterior part of the eye. The lens was clear; tension was 16 mm. of mercury (original Schiøtz). The temporal half of the fundus showed many vitreous opacities, forming a network, which was visualized best with a + 12 D. lens; they converged to form a strandlike structure, which continued toward the retina. No retinal atrophy was seen near the site of the injection of penicillin.

COMMENT

Local and systemic treatment with penicillin in the form of drops, combined with administration of a sulfonamide compound and fever therapy, checked the infection in the anterior part of the eye.

Deterioration of visual function continued; the intravitreal injection of penicillin stayed the abscess in the vitreous.

Considerable corneal irritation followed prolonged and frequent use of penicillin drops in high concentration (2,500 units).

An alarming, but temporary, increase in ocular tension was observed about twenty hours after the intravitreal injection of penicillin. Whether the latter complication arises only in eyes with glaucoma or in eyes which have been operated on for glaucoma, further observations will be necessary to determine. The increase of tension arose in an eye with a trephine opening in the corneoscleral junction.

A check-up ten months later revealed no visible damage to the retina or to adjoining structures at the site of the intravitreal injection.

Repeated infections of the bleb did not result in formation of scar tissue but led to thinning of its conjunctival covering, which ruptured spontaneously, with emptying of the anterior chamber.

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Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

COURSE OF THE PUPILLARY FIBERS IN THE OPTIC NERVE. A. BAKER, Ophthalmologica **104:** 233, 1942.

Cases are reported in which paralysis of the direct light reflex followed an injury to the optic nerve, whereas central visual acuity remained good. The optic disk showed atrophy. The consensual light reflex of the opposite eye was also abolished. The author believes that there are no facts known which make it necessary to assume the existence of separate pupillary and visual fibers.

F. H. ADLER.

CIRCULATION OF BLOOD IN THE EYE. F. KISS, Ophthalmologica **106:** 225 (May-June) 1943.

The eyes of newborn and adult human beings, rabbits, dogs and cats were given injections of india ink and then examined histologically. Some of the injections were made in the trunk of the ophthalmic artery and in the facial vein. The vascular system surrounding the canal of Schlemm was injected by introducing a needle with the material to be injected directly into the canal. The resorption of aqueous was determined by injecting the ink directly into the anterior chamber and killing the animals from six to twenty-four hours later. The preparations showed that the vasculature of the ciliary body consists of two parts: (1) broad vessels of the ciliary process, and (2) narrow vessels confined to the region of the ciliary muscle. The first system is concerned with the production of aqueous, whereas the second forms the paths of resorption. It may be considered a second capillary region connected with the large veins of the iris. These veins, together with those from the canal of Schlemm, are bent here at a right angle or have a spiral course, so that when the intraocular pressure is increased the drainage in the veins may be impeded.

F. H. ADLER.

Bacteriology and Serology

A COMPARATIVE STUDY OF THE BACTERIOLOGIC FLORA OF NASAL AND NASOPHARYNGEAL MEMBRANES OF PATIENTS WITH CERTAIN OCULAR DISORDERS. C. BERENS and E. L. N. CUMMING, Am. J. Ophth. **28:** 1313 (Dec.) 1945.

In a study of 277 sets of cultures of material from the nasal and nasopharyngeal membranes of 228 patients, Berens and Cumming found that in most instances cultures from both the nasal and the nasopharyngeal membrane are a far more reliable index of the presence of possible etiologic pathogens than are cultures from either site alone. Preliminary investigation suggests the necessity of securing cultures

from more than these two sites in order to obtain a satisfactory bacteriologic picture of the upper respiratory tract.

W. S. REESE.

Conjunctiva

THE SULFONAMIDES IN OPHTHALMIA NEONATORUM. A. SORSBY and E. L. HOFFA, Brit. M. J. **1**: 353 (March 11) 1944.

An earlier report on 273 patients with ophthalmia neonatorum treated with sulfapyridine was published in the *British Medical Journal* (**1**: 323, 1942) and abstracted in the ARCHIVES (**28**: 342 [Aug.] 1942). In the present series the standard dose (a total of 2.5 to 4 Gm.) was used in an additional 258 cases. Sulfapyridine was employed in 133 cases; sulfathiazole, in 43 cases; sulfamezathine (dimethyl derivative of sulfadiazine), in 28 cases, and sulfadiazine, in 31 cases. In the remaining 23 cases more than one of these sulfonamide compounds was used, as there proved to be resistance or intolerance to the drug initially employed.

Of these 258 cases, clinical cure was obtained within eight days in 85.7 per cent, within three days in 29.9 per cent and in from four to eight days in 58.8 per cent; in 14.3 per cent the course was protracted. There was no appreciable difference in the action of the four sulfonamide drugs. Sulfapyridine, because of its greater toxicity, was the least desirable, and its use has been abandoned. Gonococcic infections responded more rapidly to sulfonamide therapy than did the nongonococcic infections. Inclusion bodies were found in 27 cases, in association with organisms in 2 cases and without such association in 25 cases. In these cases the infection responded well to sulfonamide therapy. Only exceptionally is a condition completely resistant to sulfonamide therapy. It is a matter of sluggish response rather than of total resistance.

ARNOLD KNAPP

Cornea and Sclera

MEGALOCORNEA. E. ROSEN, Am. J. Ophth. **28**: 1352 (Dec.) 1945.

Rosen reports the case of a 26 year old soldier who showed bilateral megalocornea associated with embryotoxon, Krukenberg spindle, aqueous flare, iridodonesis and atrophic iris and dislocated lens. The author discusses megalocornea, taking issue with the statement that it is the "matter of a completely healthy eye in a healthy person." From a study of the literature it seems that megalocornea is not commonly associated with arachnodactyly, though the author has seen 1 case.

W. S. REESE.

MODERN TATTOOING OF THE CORNEA. C. DJACOS, Arch. d'opht. **5**: 36, 1945.

The author points out that sympathetic ophthalmia has been a frequent complication of this procedure in the past and has been the cause of its falling into disrepute. In this paper he reviews Rollet's method of injecting india ink into a leukoma through a fine needle. The details of the procedure are described and 5 cases reported in detail. Djacos also describes the method of P. Knapp, in which a solution of gold

chloride is used. This is applied with a cotton swab after abrading the corneal surface. He reports 2 cases, in 1 of which treatment was a failure. He thinks that Rollet's method is much the better of the two and that it is much more easily controlled. S. B. MARLOW.

NODULAR KERATITIS PRODUCED BY CATERPILLAR HAIRS. G. GARIBAY and A. CORTES ZAVALA, An. argent. de oftal. **5:** 136 (Oct.-Dec.) 1944.

A man aged 23 was awakened by a feeling of smarting in the lids of the right eye. A caterpillar was found in the bed.

Ophthalmic examination revealed edema of the upper lid, photophobia, lacrimation, conjunctival infection, a number of small corneal lesions, which stained, and iritis. The corneal lesions resembled those of superficial punctate keratitis, but the severity of the ocular symptoms did not compare with those of that disease.

Observation with the slit lamp showed that a series of white dots went deep into the corneal parenchyma, and in most of them a filament was present. These were the hairs of the caterpillar. Nodular formations, as observed by other authors, were not seen in the cornea or the conjunctiva.

All the hairs were extracted, and the patient improved immediately. The keratitis, or, rather, the ophthalmia produced by hairs of the caterpillar, as the author states it should be called, is caused by a poisonous substance which is secreted by glands located in the dorsal aspect of the worm and contained in the central canaliculi of the hairs.

H. F. CARRASQUILLO.

Experimental Pathology

RELATION OF ADRENAL GLANDS TO INTRAOCULAR PRESSURE. M. RADNOT, Ophthalmologica **108:** 137 (Sept.) 1944.

One adrenal gland was extirpated in a series of rabbits and the intraocular pressure measured with a Schiøtz tonometer for six days after operation. The author states that the intraocular pressure is lowered on the side of the operation. F. H. ADLER.

General

TYPES, PAPER AND PRINTING IN RELATION TO EYESTRAIN. R. B. FISHENDEN, Brit. J. Ophth. **30:** 20 (Jan.) 1946.

In considering briefly some points of interest, several assumptions are made. Illumination is on the basis of bright diffused daylight or artificial illumination, say, 20 foot candles. The papers used are either white or lightly tinted, and the printing is done in black ink.

In the design of types there should be no serious departure from accustomed shapes. Except for configuration, the major factor in type legibility is size. Legibility depends on the size of the small, or lower case, letters. Legibility will be reduced if the letters of the words are packed too closely, and it will be improved by inserting a space between the lines of type. There are four types, all of good design, widely used: Baskerville, Fournier, Walbaum and Times. W. ZENTMAYER.

PATHOGENESIS OF OCULAR COMPLICATIONS OF ARSPHENAMINE DERMATITIS. S. VON PASTINSZKY, Acta dermat.-venereol. **24:** 480 (March) 1944.

Of 3 patients who had dermatitis with ocular complications as the result of antisyphilitic treatment with arsphenamine, the first had panophthalmitis, the second superficial keratitis punctata and the third corneal edema. Von Pastinszky has observed that conjunctivitis is frequent in arsphenamine dermatitis with ocular involvement, but superficial keratitis is rare and corneal ulcers with perforation and panophthalmitis are still rarer. This is due to the fact that allergic inflammations are not as likely to develop in the cornea as in the conjunctiva. In addition to the allergic factor, secondary infection, lack of resistance, hypovitaminosis and perhaps mechanical factors may play a part. The allergic nature of the inflammation is indicated by the extreme eosinophilia demonstrable in the conjunctival secretion.

J. A. M. A. (W. ZENTMAYER.)

General Diseases

THE OCULAR COMPLICATIONS OF LEPROSY. J. M. DEBARROS, Am. J. Ophth. **29:** 162 (Feb.) 1946.

DeBarros states that leprosy has a higher percentage of ocular involvement than any other systemic infection. This involvement is restricted to the anterior segment, especially the cornea. Iritis is found only in conjunction with corneal disease. The author discusses the complication from an anatomic standpoint.

W. S. REESE.

MALARIAL PAPILLITIS. R. B. LEWY, War Med. **7:** 341 (June) 1945.

Lewy examined a total of 60 patients for evidence of papillitis. Some blurring and/or change in color of the optic disk was presented by 36, while the other 24 presented no change. Ocular symptoms were usually mild. Many of the patients said their eyes tired easily. A number stated that they had blurring of their vision at about 50 yards (45 meters). Many of these patients had headaches, but this had to be discounted as this symptom was common to many patients with malaria who had no ocular changes. Visual loss shown on the Snellen test chart was from 20/15 to 20/20 or 20/20 to 20/25. One patient lost vision to 20/100 in the right eye and 20/400 in the left. It is recognized that the difference between papillitis and papilledema may be slight ophthalmoscopically. It is also recognized that exudate or edema may be present in the neural or supporting tissue of the optic nerve as a product of either inflammation or stasis. This condition is considered a papillitis because of the injected appearance of the nerve head in the majority of the patients and because many showed a disturbance in the ocular physiology, e. g., diminution of visual acuity, reduced peripheral fields and enlarged blindspot scotomas. No absolute correlation could be made between the amount of papillary change and the number of attacks of malaria. The condition has been observed in patients with one attack and with eighteen. The question may be raised whether medication is the cause. None of the group of patients presented the retinal ischemia, arterial spasm and blindness characteristic of quinine amblyopia, which is often the cause of toxic retrobulbar

neuritis resulting in complete central blindness and pallor of the disk. One patient had a characteristic picture of the nerve head although he had never received quinacrine hydrochloride. The great increase in the use of quinacrine hydrochloride coincided with a drop in the incidence of malaria and papillitis. This should remove suspicion from quinacrine hydrochloride as a causative factor. There are many patients with papillitis who never received pamaquine naphthocate.

J. A. M. A. (W. ZENTMAYER.)

HISTOLOGIC CHANGES ASSOCIATED WITH RHEUMATIC INFECTION OF THE EYE. J. BABEL, Ophthalmologica **104:** 243, 1942.

The author reports a case of sclerotenonitis occurring in a man aged 35 with endocarditis and myocarditis of rheumatic origin. The patient died, and a complete autopsy was performed, including the eyes. Death occurred while the sclerotenonitis was in the process of recovery. The slides showed involvement of the sclera and Tenon's capsule as well as the ciliary body. The external ocular muscles also showed characteristic myocytes with nodules. Throughout the tissues there were perivascular infiltrates made up of plasma cells, lymphocytes and round, basophilic cells of histiocytic origin. The same histologic changes were seen in the myocardium, the endocardium and the synovial membranes.

F. H. ADLER.

Glaucoma

NONPERFORATING CYCLODIATHERMY FOR THE TREATMENT OF GLAUCOMA. F. C. LUTMAN, Am. J. Ophth. **29:** 180 (Feb.) 1946.

Lutman recommends cyclodiathermy in hopeless cases for the relief of glaucomatous pain in preference to enucleation, retrobulbar injection of alcohol or roentgen irradiation. He states that it is particularly suitable in cases of glaucoma in which vascularization of the iris precludes operation on the iris or of glaucoma following venous thrombosis.

W. S. REESE.

CATARACT AND CHRONIC GLAUCOMA. C. DUVERGER and P. BREGEAT, Arch. d'opht. **5:** 3, 1945.

Cataract and chronic glaucoma can develop in the same eye at the same time or one after another but without any relationship between them. Such a condition is sometimes difficult to diagnose. The surgical problem involved is first to protect the limbus above for a fistulizing operation and to operate on the cataract by an incision in the lower part of the limbus. If a membrane remains and the glaucoma still requires operation, the authors advocate doing a Lagrange sclerectomy above for operating on the membrane. Operation for glaucoma will be performed first even if the cataract is mature when the field of vision is restricted and the tension is above 30 or 40 mm. The cataract is removed later. In some of the cases in which the authors have performed operation the outcome has been very favorable. Sometimes the vitreous does not obstruct the fistula, which continues to function, and the vitreous remains clear. As a rule, the glaucoma is the chief cause of visual loss.

S. B. MARLOW.

Injuries

ORBITAL FOREIGN BODIES. M. L. KRASNOV, Vestnik oftal. 23: 10, 1944.

A Navy school student aged 18 had been hit with a fist in the nose and the right orbit two weeks previously. There was loss of consciousness, accompanied with bleeding of the nose and vomiting.

The right upper lid was slightly edematous, and some roughness of the edge of the upper inner margin of the obit could be detected on palpation. The media and fundus were normal. Visual acuity was normal.

The left eye presented total ophthalmoplegia; the pupil was dilated, with no reaction to light. The optic nerve was pale. The eye was blind. Roentgenograms showed nothing abnormal.

A few days later swelling of the skin of the right brow near the nasal side appeared, followed by some fluctuation. On incision a piece of pencil, 6 cm. long, was found deep in the orbit. Two weeks later the ptosis of the left eye had nearly disappeared and the motion of the left eyeball was only slightly limited, but vision remained nil and the atrophy of the optic disk was complete.

The interest of this case lies in the fact that the presence of a large (6 cm.) intraorbital foreign body was missed because of the history, the clinical picture and the normal roentgenogram; that such a large foreign body, in its oblique frontal entry and injury of both orbits, did not injure the eyeballs, and that there was no infection, so common in the presence of a wooden foreign body.

The roentgenogram taken after removal of the foreign body showed destruction of the bone about the left supraorbital fissure. It seemed that the piece of wood passed with force through the skin of the right brow and the medial wall of the right orbit, passed obliquely first through the right ethmoid bone and then through the left and finally lodged at the apex of the left orbit, injuring the bone in the supraorbital fissure and thus causing the total ophthalmoplegia.

O. SITCHEVSKA.

RESULTS OF THE USE OF SECONDARY SUTURES IN GRANULATING WOUNDS OF THE LIDS AND NEIGHBORING REGIONS. P. KOWALEWSKY, Vestnik oftal. 23: 45, 1944.

Observations in N. Hospital showed that in 95 per cent of patients there was combined injury of the eyeball and the lids, the lids were partially or completely torn away and the bones of the orbit and the sinuses were injured. The multiplicity of injuries is characteristic of World War II, because of the intensity of trauma from fragments of mines, artillery shrapnel, aviation bombs and hand grenades.

The primary suturing of the lids and surrounding skin should be done carefully within six hours after injury in order to prevent large, deforming scars. However, about 60 per cent of patients with injuries of the eyes reached the hospital within four to eight days after the injury with granulations beginning to form. Secondary suturing of the wound at this stage by approximation of the lips of the wounds usually gave good union.

Late secondary suturing of injured lids is indicated (1) in injuries of lids in which the edges could be completely approximated; (2) in

extensive injuries of the lids and neighboring parts with restoration of the conjunctival sac, as well as in injuries of the inner and external canthi, and (3) for the reduction of size of the wound, the sutures to be applied only in places where the edges can be approximated.

In infected wounds the secondary sutures are most favorable, placed on the eighth to the twelfth day after the injury. With injuries of the orbit removal of all fragments of bone is essential. The granulation tissue should be preserved; if necessary, double sutures can be used for the granulation tissue and for the skin. In the presence of deep pockets drains should be used. The bacteria found were the white staphylococcus, the diplococcus and the streptococcus; frequently a mixed infection was present. An ointment containing sulfanilamide in 10 per cent concentration and a sterile dressing gave a dry clean surface in two to three days.

Secondary sutures for the lids were used in 187 patients; in 81 per cent there was a smooth scar with primary union; in 11 per cent there was slight infection of the wound, and in 8 per cent the sutures had to be removed because of secondary infection.

Thus, Kowalewsky advocates the use of secondary sutures in injuries of the lids and adjacent parts, as, after careful preparation of the wound, they produce a smooth scar. This effect is important for cosmetic results and shortens the time of hospitalization.

O. Sitchevska.

Methods of Examination

A Trick Test to Detect Night-Blindness "Malingerers." E. Epstein and S. A. Hugh Lesser, Brit. M. J. 2: 644 (Nov. 10) 1945.

Tests of scotopic vision are all subjective and demand the cooperation of the patient. From a military point of view it is important to discover those who simulate night blindness, and the authors have devised the following procedure: They first attempt to show that the subject is cooperating fully. In that case any one of the various tests can be relied on. It is known that red light stimulates the cones of the retina only and that the rods are unaffected. This means that in subjects with normal central vision pure red light should be identified at minimal intensity even if the rest of the retina is diseased or defective. The minimum threshold for pure red falls within a narrow range of intensity of illumination. A subject with defective night vision but with normal cones should be able to see the red light within this narrow range of minimal intensity.

The method is as follows: After a careful routine examination, including tests for color vision, the subject is placed in a dark room and left to adapt to darkness for twenty minutes. After this time he is asked to state when he can just see the faint red light which is shown him and which is increased gradually in intensity. This test is repeated a number of times to determine whether the patient is cooperating or not. The malingerer reasons that he must not admit seeing the light until it is very bright, which, of course, does not correspond with normal macular function.

The apparatus used is Crooke's adaptometer 1944, which is fully described in the text, with a diagram. The subject is at first tested without spectacles. It was found that many patients with high refractive errors gave subnormal results without their glasses and normal readings with them. Patients with small refractive errors usually gave the same result with or without glasses. A number of illustrative cases complete the article.

ARNOLD KNAPP.

Neurology

PHENOMENON OF VISUAL EXTINCTION IN HOMONYMOUS FIELDS AND PSYCHOLOGIC PRINCIPLES INVOLVED. M. B. BENDER and L. T. FURLOW, Arch. Neurol. & Psychiat. **53**: 29 (Jan.) 1945.

The authors reviewed cases of syndromes due to cerebral injuries reported in the literature in which signs of "visual inattention in homonymous fields" or "hemianopsic weakness of attention" were noted. They studied a case of this type over a long period and found that the failure to appreciate an image on one side is not due to inattention but is the result of underlying normal psychologic mechanisms. They report this case in detail and discuss psychologic principles involved in a most interesting and instructive manner. In this case, in which a soldier had a gunshot wound of the left occipitoparietal cortex, various psychologic mechanisms became apparent during the advanced stages of restitution of visual function from right homonymous hemiamblyopia. Visual stimuli originating in the normal homonymous field of vision tended to suppress or obscure the image originating simultaneously in the opposite, affected, field of vision. The more stimulation there was in the normal field, the less the patient saw in the pathologic field of vision. The affected field showed fluctuation of sensation. Rivalry, dominance and attention mechanisms are considered explanatory principles.

S. R. IRVINE.

DENIAL OF BLINDNESS BY PATIENTS WITH CEREBRAL DISEASE. F. C. REDLICH and J. F. DORSEY, Arch. Neurol. & Psychiat. **53**: 407 (June) 1945.

The authors observed 6 cases of denial of blindness over a period of eighteen months in a 600 bed hospital. This fact demonstrates that the syndrome is not rare, but it is easily overlooked unless the examiner is aware of its existence. One is inclined to believe the statement of the patient who says he can see without an attempt at verification. Furthermore, most examiners are reluctant to make any attempt to stress forcibly to the patient such a severe defect as blindness. All patients who present such a syndrome are deteriorated and have disturbances of retention and orientation, hallucinations and delusions; and neuropsychiatrists may look at their denial of blindness as one of many psychotic manifestations. Moreover, in most cases it is of little practical significance whether these blind patients affirm or deny their blindness, and the syndrome is therefore predominantly of theoretic interest.

The syndrome was caused by diabetic retinopathy in 1 patient, by atrophy of the optic nerve in another and by bilateral hemianopsia due

to tumor or to vascular lesions in 4 patients. Moreover, all patients had diffuse cerebral lesions. All showed intellectual deterioration: disorientation, severe impairment of recent memory and retention, and confabulation. The existence of bilateral focal lesions of the visual radiations or of the occipital visual areas leading to bilateral hemianopsia seems to play an important role in the pathogenesis of the syndrome. The interruptions of reverberating circuits between the thalamus and the sensory cortex constitute the outstanding etiologic factor.

S. R. IRVINE.

OPTICOCHIASMIC MENINGITIS: CLINICAL ASPECTS. PAUL GONZALEZ ENRIQUEZ, An. Soc. mex. de oto-rino-laring. **18:** 17, 1943.

The author gives a detailed discussion of the disease, illustrating it by means of a thoroughly studied case, with verification at operation and successful surgical treatment. He explains the varied symptomatology of the disease, taking into consideration the many anatomic structures in this location. Pathologically, he points out three varieties of the disease: the serous, the plastic and the cystic.

Twenty-seven per cent of cases of this condition occur between the ages of 20 and 30. As possible causes he mentions extension from the paranasal sinuses, syphilis, tuberculosis, infection with the colon bacillus, encephalitis, rheumatism and trauma.

The symptoms are local and general. General symptoms are headache, vertigo, vomiting and initial low grade fever. Local symptoms may be (1) optic; (2) hypophysial, infundibular or hypothalamic, or (3) frontal (disturbance of the first cranial nerve).

The ocular symptoms are most important: They include slight alteration of visual acuity (greater in cases of chiasmic involvement, in which atrophy frequently occurs); initial changes in the visual fields, with a temporal cut in the cases of chiasmic meningitis and concentric contraction in the cases of prechiasmatic involvement, and a central scotoma (in 31 per cent of cases). The appearance of the fundus is usually unchanged. The concentric contraction, before described as stellate, is the major ocular symptom.

The case presented is that of a schoolboy aged 17, whose chief complaints were intense cephalalgia and transitory states of amaurosis. He had other visual disturbances, vertigo, emotional and confusional states, polyuria, olfactory hallucinations and disturbances referable to the peripheral nerves.

The patient noted somnolence, increased weight (11 Kg.), increase in output of urine and decrease in sexual desire. Physical examination showed nervous disturbances, weakness of the right side of the face, diminished tendon reflexes in the upper extremities and peculiar alterations in tactile and heat sensibilities in the upper part of the right arm.

Ophthalmologic examination showed initial bitemporal narrowing of the visual fields, which gradually progressed to concentric contraction. A bilateral annular scotoma was also found. The changes in the fundus were of no importance.

Roentgenographic and laboratory tests revealed no abnormality. With a diagnosis of opticochiasmic arachnoiditis, operation was performed. The clinical diagnosis was confirmed. The chiasm and optic

nerves were freed from adhesions. In four months the visual fields were normal, and the patient was free of symptoms.

The differential diagnosis is discussed in detail, the condition being differentiated from hysteria, epilepsy, lesion of the occipital lobe, encephalitis, meningitis, suprasellar tumor and migraine.

H. F. CARRASQUILLO.

Ocular Muscles

THE EFFECT OF OPERATIVE ALTERATIONS IN THE HEIGHT OF THE EXTERNAL RECTUS INSERTION. J. FOSTER and E. C. PEMBERTON, Brit. J. Ophth. **30:** 88 (Feb.) 1946.

The authors have obtained the following effect from operative alteration of the height of the insertion of the external rectus muscle:

	Prism Diopters
Whole width raising with resection and advancement	11.2
Whole width raising with resection alone	7
Half-width raising with resection and advancement	9
Half-width raising with resection alone	5.4
Half-width raising on the internal rectus muscle	2.75

From the results obtained from this procedure in 26 cases of concomitant squint, the authors conclude there is some justification for this operation when the vertical error is constant and less than 11 prism diopters at all horizontal angles. The eye moves in the direction in which the insertion is moved, and this movement is independent of the position of the conjunctiva.

W. ZENTMAYER.

Operations

FULL THICKNESS SKIN GRAFTS FROM NECK FOR FUNCTION AND COLOR IN EYELID AND FACE REPAIRS. J. B. BROWN and B. CANNON, Ann. Surg. **121:** 639 (May) 1945.

Brown and Cannon say that full thickness skin grafts from the neck and the clavicular region have been found to give superior results in the repair of facial defects. The amount of skin available is limited, but there is enough for the eyelids, for the nose and about the mouth. The color is nearly always close to that of the normal face. None of these grafts so far have had to have injection of pigment for color matching, whereas the dead whiteness or darkness of other grafts often leaves much to be desired. The second advantage is softness, and therefore better function. These grafts heal and have such thickness that the best kinesis of the grafted areas can develop. This property is best expressed in repairs of the eyelid, in which hard, boardlike scars of gasoline and phosphorus burns have been literally dug out of the lids and of the area from one eye to the other over the nose. When these areas are covered with the grafts from the neck, there are often dramatic relief of scar fixation and return to softness and function. The main areas for use of these grafts are on the lids, in the canthal regions, about the alae, over the nose and about the lips and angles of the mouth. As a rule, flap repairs are considered preferable for gunshot wounds, whereas grafts usually suffice for burns. However, about the lids, if a bed at all suitable can be obtained by dissection of the scars, these full

thickness grafts are used in preference to flaps and, it is thought, with better results. Donor sites can be closed, left open to granulate or grafted. They may make troublesome scars for a while, but no permanent serious trouble has been seen.

J. A. M. A. (W. ZENTMAYER.)

TWO STEP METHOD OF PLASTIC REPAIR OF THE CONJUNCTIVAL SAC. B. TOVBIN, Vestnik oftal. **23:** 30, 1944.

Excessive bleeding often interferes with the taking of conjunctival transplants. Tovbin therefore performs plastic operations on the conjunctiva in two steps. After having made the necessary incisions, a gauze tampon is packed into the conjunctival sac so as to produce the desired shape and is left there for three days; then the transplant is inserted. It usually takes well and does not shrink, and the prosthesis stays in well.

O. SITCHEVSKA.

Orbit, Eyeball and Accessory Sinuses

MALIGNANT EXOPHTHALMOS OR EXOPHTHALMIC OPHTHALMOPLEGIA. C. ROBERTSON, Australian & New Zealand J. Surg. **14:** 262 (April) 1945.

Robertson reports 9 cases in which exophthalmos increased in spite of relief of the toxic symptoms. The suggestion that a different factor is at work in the production of malignant exophthalmos than is responsible for the exophthalmos of ordinary toxic diffuse goiter receives strong presumptive evidence when the age and sex grouping in the two conditions are compared. Toxic diffuse goiter is a disease of early adult life and is much more common in females than in males, while the malignant type of exophthalmos occurs in patients aged 40 or over and the sex incidence is almost reversed. Of the 9 patients, 6 were men and 3 women. In many cases the disease gradually dies out, but it often leaves the patient with an unsightly deformity and sometimes double vision. Only occasionally has complete regression of the exophthalmos occurred. In other cases the condition progresses until the disorganization of the eyeball is so great that excision of the globe has to be performed. It is now generally accepted that there is edema of all the orbital tissues outside the globe, and this increase in size of the orbital contents pushes the eyeball forward. It also restricts the free movements of the eyeball. It seems certain that the hormone responsible for the orbital edema is different from the one which produces the other signs of thyrotoxicosis. Since edema is a sign of water imbalance and since water balance is influenced by the pituitary gland, a pituitary hormone may be involved. Robertson treated 4 patients with Naffziger's method of decompression of the orbit; 1 had excision of the stellate ganglion, and 2 had high voltage roentgen therapy to the pituitary gland. None of these methods produced the desired results; some patients lost one or both eyes. Three patients whose metabolic rate was slightly minus after thyroidectomy were given thyroid when the eyelids became edematous and ophthalmoplegia appeared. The resulting increase in the metabolic rate increased the loss of body fluids, and the eyes receded. For 5 patients who did not receive surgical treatment therapy consisted in

raising the basal metabolic rate so as to increase water excretion. In all of them the disease was controlled.

J. A. M. A. (W. ZENTMAYER.)

Uvea

IRIDOSCHISIS, WITH MULTIPLE RUPTURE OF STROMAL THREADS. A. LOEWENSTEIN and J. FOSTER, Brit. J. Ophth. **29:** 277 (June) 1945.

After a brief summary of previously reported cases characterized by local division of the stroma of the iris into two layers, the anterior of which floats in the aqueous, the authors summarize the clinical and histologic features of their own case.

In a woman aged 75 long-standing glaucoma changes in the iris consisted in a deep cleft between the anterior and the posterior layers of the stroma of the iris, parallel with the latter. The anterior layers were largely atrophic, and such tissue as remained was split into fibers, which were centered on a blood-containing vessel. These fibers were attached to the ciliary portion of the iris distally and were floating free in the aqueous.

The name iridoschisis for these changes is suggested.

The clinical and histologic observations suggest that the mechanism of these changes is the exaggeration of a physiologic aging process of the iris, in which the middle layers became atrophic. Subsequently the two layers are separated, and finally the threads of the anterior layer which remain and contain a blood vessel rupture and float free at one end.

The basic change is senile, but the process may be aggravated by proteolytic enzymes (lysins) in the aqueous, the product of glaucomatous metabolism.

The article is illustrated.

W. ZENTMAYER.

Therapeutics

THE SUITABILITY OF EXPERIMENTAL CORNEAL LESIONS FOR EVALUATING LOCAL SULPHONAMIDE THERAPY. W. T. S. COLE, J. L. HAMILTON-PATERSON AND ARNOLD SORSBY, Brit. J. Ophth. **29:** 150 (March) 1945.

Attempts to produce infective corneal lesions suitable for therapeutic tests in the rabbit with Pneumococcus types III and XIX by direct inoculation of the abraded cornea in the intact animal, by direct inoculation of the cornea after damage with solid silver nitrate and by direct inoculation exposure of the cornea by retracting the lids with sutures, all failed. Preliminary sensitization also failed to produce any satisfactory lesion on inoculation with the hemolytic streptococcus.

The method of intracorneal inoculation with Pneumococcus type XIX and Staphylococcus aureus, as described by Robson and Scott, did not appear to give lesions suitable for therapeutic tests.

In vitro experiments with Bacillus pyocyaneus to test the possibility that the conflicting results reported by Robson and Scott, on the one hand, and Klein and Sorsby, on the other, might be due to varying susceptibility of different strains of the organism to sulfanilamide gave negative results.

It is concluded that there is no valid experimental evidence that local use of sulfonamide compounds is effective in treatment of infections of the outer eye.

W. ZENTMAYER.

MODERN ANTI-INFECTION TREATMENTS IN OPHTHALMOLOGY. A. MOREU, Arch. Soc. oftal. hispano-am. **4:** 392 (May-June) 1944.

Moreu treats the serious condition of serpiginous ulcer of the cornea as follows: (1) A smear is made of material from the ulcer; (2) the lacrimal passages are explored; (3) if impermeable, these passages are treated immediately by means of dacryocystorhinostomy or dacryocystectomy, without wasting time in probing and irrigations; (4) atropine, 1 per cent, is instilled; (5) heat is applied; (6) 10 cc. of milk is injected intramuscularly and (7) sulfamidotherapy (administration of sulfathiazole, up to 10 Gm. in twenty-four hours) is instituted. All these steps are carried out within the first twenty-four hours after the patient is seen. If no improvement results, local treatment is begun at once. If there is improvement, one should wait forty-eight hours before instituting it. Local treatment consists in paracentesis of the anterior chamber at the limbus at 6 o'clock and letting out all the aqueous. Two cubic centimeters of blood is taken from the patient and 0.25 cc. of this blood is injected into the anterior chamber, using a lacrimal cannula. The rest of the blood is put into a contact lens, which is placed over the cornea and kept there for two hours by means of a pad and adhesive tape. The author claims that this treatment cures the ulcer.

Purulent iridocyclitis after cataract extraction was successfully treated as follows: Ten cubic centimeters of milk was injected; heat was applied; atropine and ethylmorphine hydrochloride were instilled; 20 tablets of sulfacetimide were administered in twenty-four hours, together with 3 tablets of nicotinic acid and 3 tablespoons of liver extract. The next day local treatment was instituted by injecting the patient's own blood into the anterior chamber. Another patient with a nonoperative condition was treated in the same way. Both patients were cured and regained normal vision.

H. F. CARRASQUILLO.

TREATMENT OF BURNS OF THE FACE WITH GRENZ RAYS. M. BALTIN, Vestnik oftal. **23:** 27, 1944.

Baltin treated a number of burns of the face and lids of second degree with grenz rays. The effect of the treatment was noticeable in a few days, as the oozing stopped, the scales disappeared and epithelization began. One week of daily irradiation was sufficient to obtain good results.

O. SITCHEVSKA.

Society Transactions

EDITED BY DR. W. L. BENEDICT

ANNUAL CONGRESS OF THE OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

Charles B. Goulden, M.D., *President*

Frank W. Law, M.D., *Secretary*

J. H. Doggart, M.D., *Reporter*

May 30 and 31 and June 1, 1946

Nearly 250 people, including some 50 visitors, attended the annual congress of the Ophthalmological Society of the United Kingdom, held on May 30 and 31 and June 1, 1946, at the Royal Society of Medicine, 1 Wimpole Street, London, W. 1, under the presidency of Charles B. Goulden, O.B.E., M.D., M.Ch., F.R.C.S. The success of this gathering was enhanced by the welcome presence of a number of distinguished foreign visitors, most of whom had been isolated in their own countries since 1939.

During his address of welcome to the guests and members, the president dwelt with satisfaction on the fact that many of the visitors from abroad were already old friends of British ophthalmologists. Special delight was expressed concerning the arrival of this year's Bowman lecturer, Dr. Arnold Knapp, from the United States, and the president reminded his listeners that an invitation to deliver the Bowman lecture represented the highest compliment that could be paid by the society. He was confident, however, that Dr. Knapp would maintain the tradition established by illustrious Bowman lecturers of former years. A cordial welcome was also extended by the president to Dr. P. Mérigot de Treigny, the honorary secretary of the French Ophthalmological Society; to Prof. H. J. M. Weve and Dr. E. C. Gravemeyer, from the Netherlands; to Dr. L. Coppez, Dr. L. Bauwens, Madame Van Boven and Dr. C. L. Schepens, from Belgium; to Prof. B. Semadini, Dr. A. Franceschetti and Madame Noëlle Chomé, from Switzerland; to Dr. W. H. Melanowski, from Poland; to Dr. H. Gjessing, from Norway; to Dr. Gunnar von Bahr, from Sweden, and to Dr. Miguel Millan, from Chile. Before proceeding to deliver his presidential address, Mr. Goulden referred hopefully to the prospect of an international congress being held in Europe in 1948.

The subject of the presidential address was Johannes Evangelista Purkinje, whose work, like that of many other eminent pioneers, was not recognized at its true merit until after his death. One obvious explanation for this neglect by his contemporaries was the fact that Purkinje's studies in clinical ophthalmology were written in ecclesiastical Latin. Moreover, he was often handicapped, especially in his earlier years, by lack of money and equipment. Mr. Goulden reminded his

audience that Purkinje was born of poor Bohemian parents in 1787 and that he began to study for the priesthood at the age of 15 years. These studies, however, were abandoned at the age of 21, when Purkinje entered the School in Medicine in Prague. After a period spent as lecturer on anatomy at Prague, he moved to Breslau, where he achieved much notable work on microscopic anatomy, although at first he was denied the advantage of access to a proper microscope.

The president particularly stressed the versatility of Purkinje, whose work was by no means confined to ophthalmologic subjects. He made numerous discoveries in the realms of clinical medicine and pharmacology, as well as important contributions to the study of fingerprints. Among ophthalmologists his name is immortal, because the mirror reflections of a source of light by the cornea and by the anterior and posterior surfaces of the lens are known collectively as Purkinje's images. The name of Purkinje is also associated with a number of those entoptic phenomena which he studied with remarkable ingenuity.

A discussion on "Ocular Disturbances Associated with Malnutrition" was opened by Mr. Harold Ridley, who described the results of his army experiences among released prisoneers in Rangoon, Singapore and other Far-Eastern centers. His address, which was packed with carefully assembled facts, was delivered at a high speed that prevented his listeners from appreciating all his lines of argument, but there is no doubt that study of the published paper will be interesting and informative to many of Mr. Ridley's colleagues. He frankly recognized the difficulty of deciding to what extent malnutrition was responsible for ocular lesions among people who were in many instances the victims of malaria, dysentery and other tropical maladies in addition to being underfed. He also admitted that it was impossible to define the exact stage at which relative pallor of the temporal side of the optic disk exceeded physiologic limits. One feature stressed by this speaker was the speed with which failure of central vision may develop in cases of riboflavin deficiency, so that the patient may suddenly become aware that he cannot distinguish the faces of his friends. In Mr. Ridley's experience the typical field defect was a scotoma involving the central 3 degrees. Constriction of the peripheral field was infrequent. Pallor of the optic disk, involving the temporal more than the nasal half, was the commonest ophthalmoscopic finding, but some patients displayed macular disturbance associated with obliterative changes in the arteries supplying the center of the fundus. Mention was made of partial recovery of vision in some cases, and the benefits of liver therapy were stressed. With regard to the somewhat controversial question of vascular arcades invading the periphery of the cornea, Mr. Ridley suggested that any lasting engorgement of the conjunctival vessels, whether due to riboflavin deficiency or not, can lead to this form of vascularization.

Air Commodore P. C. Livingston, the other speaker on this subject, was absent on Far-Eastern service, but Mr. Frank W. Law, the honorary secretary of the society, read extracts from his contribution. Air Commodore P. C. Livingston, assisted by a team of medical assistants and orthoptists, had observed a series of prisoners of the Royal Air Force returned from Japanese camps. Many of these victims had been compelled to perform heavy work on a diet containing less than one-third

the calories required for such activities. Among 3,000 men, however, only 200 (i.e., less than 7 per cent) suffered from visual defect. He pointed out that the prevalence of dysentery and other intestinal disorders often rendered the prisoners incapable of utilizing the whole of their inadequate diet, owing to its rapid passage through the bowel. The possible etiologic role of tobacco and wood alcohol in these cases of so-called nutritional amblyopia was discussed. According to Air Commodore Livingston, other changes in the fundus besides partial atrophy of the optic nerve are by no means uncommon. Partial veiling of the retinal vessels by wisps of connective tissue was mentioned, and he also spoke of impaired macular definition, or actual dots of degeneration or pigmentary stippling at the macula. Diagrams neatly constructed by Flight Officer Gwilt to illustrate central and peripheral field defects were shown. Air Commodore Livingston also described the generous diet by means of which returning prisoners were built up, but he said that only a minority showed any recovery in visual acuity or diminution in the central scotoma.

When the subject was declared open for discussion, most of the available time was occupied by those who had previously notified their intention of taking part. Mr. T. Keith Lyle, recently returned from overseas service with the Royal Air Force, gave a lucid account of his experience among prisoners from the Far East. He stated that he had seldom found any macular abnormality in these men, and he also stressed the lack of correspondence between the severity of the visual defect and the depth of pallor of the optic disk. One interesting feature, he said, was fragmentation of the central scotoma during the period of recovery. In discussing the question of vascular corneal loops near the limbus, he mentioned that this phenomenon is exceedingly common in Calcutta, that the subjects also display angular conjunctivitis, glossitis and scrotal dermatitis and that all these lesions disappear when sufficient riboflavin is supplied in the diet.

Dr. Hugh Stannus expressed his disbelief in the existence of a true retrobulbar neuritis due to beriberi and suggested that the part played by riboflavin deficiency in the causation of optic neuropathy was not fully settled. Having insisted on differentiating between toxic amblyopia and nutritional optic neuropathy, he went on to suggest that the latter may be combined with larger disturbances of the central nervous system and that dendrites are vulnerable to many varieties of defective diet.

Mr. C. D. Shapland, recently demobilized from the Army Medical Service, reported that he had found evidence of a severe lesion of the optic nerve in 6 per cent of a series of 900 prisoners returned from Japanese camps. His paper contained numerous charts setting out the results of detailed medical and pathologic investigations on these patients. In the opinion of Mr. Shapland, alcohol played no part in the production of visual defect in these prisoners, and tobacco during the period of captivity was so scarce that it could not be regarded as responsible for the lesions.

Among the subsequent speakers were several who had had the opportunity to examine prisoners released from Japanese camps. Prof. H. M. J. Weve, of Utrecht, Netherlands, pointed out that, although he had found many cases of central scotoma among prisoners returning from

Java, this disability was conspicuously absent in the victims released from German camps, even though the latter included many instances of starvation. Therefore, said Professor Weve, it must be assumed the existence of factors other than malnutrition, presumably some toxin peculiar to the Far East, is associated with dietary deficiency in the production of so-called nutritional amblyopia. Mr. H. M. Traquair uttered a note of warning against the tendency on the part of some observers to assume that central scotoma necessarily indicates the presence of retrobulbar neuritis. Major Browning insisted that the condition known as beriberi is a clinical hotchpotch, that tropical medicine is in a state of flux and that his chief impression of ocular disturbances associated with malnutrition was their wide variability. Some patients complained of much pain, others had none. Retinal signs might be gross or lacking. The onset was rapid in some and slow in others. Major Browning's brief remarks helped to emphasize one inevitable conclusion to be drawn from the experiences of the various speakers, namely, that the subject is exceedingly complicated and that an immense amount of intelligently correlated research will be needed for its final solution.

Mr. Harold Ridley, who received the president's warm congratulations on his contribution to the discussion, was given a chance to reply to some of the points raised by other speakers. He disagreed with Mr. A. H. Lowther's suggestion that tobacco should be held partly responsible for the visual defects noted among returned prisoners, and he contended that deficiency of the B complex vitamins and restriction of the total protein intake were the main factors. Mr. Ridley expressed the hope that these observations by numerous ophthalmologists on the consequences of Japanese prison diet might later be utilized to prevent ocular damage among the teeming multitude of Asia and India in times of famine.

The Bowman lecture, dedicated to the memory of William Bowman, the founder of the Ophthalmological Society of the United Kingdom, was delivered during the afternoon of May 30 by Dr. Arnold Knapp, who delighted the audience with the fruits of his wide reading and rich experience. His subject, "The Present State of the Intracapsular Cataract Extraction," is one of absorbing interest to the great majority of ophthalmic surgeons, and Dr. Knapp gave careful consideration to every aspect thereof. In the course of a historical survey, he referred in detail to the work of Smith, Barraquer, Elschnig, Sinclair, Mendoza, Verhoeff, Gradle, Arruga, Amsler and others. Special attention was devoted to the selection of cases and to the difficulties and complications likely to be encountered at operation. Every stage in the operative technic was exhaustively considered, with special emphasis on the importance of proceeding without undue haste during rupture of the zonular fibers. Dr. Knapp reminded his listeners that senile thickening of the capsule is a change that usually develops concurrently with loosening of the attachment of these fibers. He went on to mention the advantages of akinesia and of retrobulbar injection. He also stated that he favored the superior rectus suture but was accustomed to leave it loose, so that it could be used in an emergency. If the suture is tied down as a routine, the intraocular pressure is raised, and vitreous more readily escapes.

Dr. Knapp stated that most of his patients underwent complete iridectomy, although he frankly recognized certain disadvantages in this step.

The question of corneoscleral suturing was carefully reviewed, and the lecturer pointed out that a properly applied suture not only diminishes the likelihood of prolapse of the iris and of hyphemia but also promotes early reformation of the anterior chamber. Dr. Knapp expressed the firm belief that the patient whose anterior chamber does not promptly reform is exposed to the risk of secondary glaucoma. Other subjects considered were the choice of speculum, the incidence of loss of vitreous (5 per cent in Dr. Knapp's later series of cases) and the occurrence of updrawn pupil, opacity of the anterior face of the vitreous and retinal detachment as sequels. The vital importance of a clean section was mentioned more than once. Dr. Knapp admitted that the intracapsular method of cataract extraction is more difficult than the extracapsular, but he claimed that on the whole the intracapsular operation is safer and more efficient. At the end of the lecture, he was warmly congratulated by Sir Stewart Duke-Elder and by the president on his masterly survey, which will be closely studied by his listeners and by a host of other ophthalmologic friends all over the world when it appears in the forthcoming *Transactions* of the society.

At the end of the first day's session, the annual dinner of the society was held in the library and council room of the Royal College of Surgeons, Lincoln's Inn Fields. The foreign guests earlier mentioned by name attended the dinner, and the wives of many guests and members accompanied them. Among the guests were Lord Moran, president of the Royal College of Physicians; Sir Alfred Webb-Johnson, president of the Royal College of Surgeons; Mr. Eardley Holland, president of the Royal College of Obstetricians and Gynaecologists; Mr. P. H. Adams, president of the Ophthalmological Section of the Royal Society of Medicine; Mr. H. S. Souttar, president of the British Medical Association; Air Marshal Andrew Grant, Director General of Medical Services, Royal Air Force; Mr. Hugh F. Powell, master of the Worshipful Society of Apothecaries of London; and Sir Wilson Jameson, chief medical officer to the Ministry of Health. The toast of the King, followed by that of the Queen, the Queen Mary, the Princess Elizabeth and the other members of the royal family, was proposed by Mr. Charles B. Goulden, the president of the Society. Sir Alfred Webb-Johnson, in proposing the toast of the society, made a graceful speech which revealed close familiarity with ophthalmologic interests. He recalled the links forged between ophthalmic surgery and the Royal College of Surgeons by William Bowman, the founder of the Ophthalmological Society of the United Kingdom, and he referred to the work of Cheselden. The president replied. To the toast of the guests, proposed by Sir John Parsons, Dr. Arnold Knapp (the Bowman lecturer) and Air Marshal Andrew Grant replied. Finally, Sir Arnold Lawson, in proposing the toast of the president of the society, dwelt on Mr. Goulden's quiet efficiency. The latter paid well deserved tribute to loyal and efficient help he had received from the honorary secretary, Mr. Frank W. Law. After the speeches had been completed, guests and members circulated for informal conversation, and many of them took the opportunity to gaze at the portraits of John Hunter, Lord Lister and other pioneers which adorn the walls of the council room at the Royal College of Surgeons.

On May 31, the second day of the congress, Dr. A. Lowenstein read a paper entitled "Perivasculitis Retinae of the Young (Eales's Disease)—a Pathologic Review." Sections of the eye and optic nerve of a man aged 21 were shown on the screen, and attention was directed to the presence of cellular infiltration of the retina. Investigations, including animal injections made with a view to detecting the presence of tubercle bacilli, septic organisms and filter passers, all gave negative results. The possible role of allergy in the production of this disease was discussed.

Dr. I. C. Michaelson's contribution, entitled "Traversing Intra-Ocular Foreign Bodies with Retinal Detachment," was also illustrated with numerous pictures. He emphasized the differentiation of two main types: (1) cases in which the flight of the foreign body is transvitreous and the ensuing detachment is attributable to immediate contusion or to bands of fibrous tissue developing in the vitreous after an interval, and (2) cases in which the flight is tangential. In the latter variety, according to Dr. Michaelson, a dense choroidal exudate is followed by contraction of white masses, visible ophthalmoscopically, and detachment can be seen to begin near the choroidal scar. No detachment, on the other hand, occurs near the wound of exit of a transvitreous foreign body. He advocated release of the subretinal fluid in cases of the second, or tangential, type of injury and insisted that no application of diathermy should be made in the neighborhood of the plastic choroiditis commonly present in such cases.

"The Nerve Fiber Pattern of the Human Retina" was the title chosen for his paper by the president elect, Mr. A. J. Ballantyne, who showed a number of diagrams to indicate the arrangement of nerve fibers spreading from the disk. He stressed the existence of a small group of uncurved fibers passing direct from the optic disk to the macula. Mr. Ballantyne expressed the view that it is not yet known exactly how the upper and lower arching fibers interdigitate, and he also suggested that the macular syncytium has never been fully explained.

Mr. Eugene Wolff's contribution was entitled "The Mucocutaneous Junction of the Lid Margin." He sketched the routes followed by tears during their passage from the lacrimal gland to the puncta and emphasized the importance of blinking as a means of promoting their distribution. In Mr. Wolff's opinion, there is no need to invoke massage by the orbicularis as an explanation for the movement of tears. Attention was specially directed to the precorneal film, which he described as consisting of three layers. The layer in immediate contact with the cornea consists of mucus derived from the conjunctival goblet cells, and Mr. Wolff suggested that these last-mentioned structures might appropriately be designated the "corneal polishing cloth." Next comes the intermediate layer, consisting of tears. Most superficial of the three layers is a thin film of meibomian secretion, which not only acts as a kind of protective "flypaper" but also serves to prevent the middle layer of tears from running away too quickly or from being dissipated by rapid evaporation. Furthermore, the meibomian secretion forms a low wall athwart the lower lid margin, thus enabling the conjunctival sac to function as a reservoir for tears. For all these reasons, Mr.

Wolff contended that the location of the mucocutaneous junction at the line of orifices of the meibomian glands must be recognized not merely as an academic fact but as a logical arrangement essential for the integrity of the cornea.

"Recent Developments in Artificial Eyes" were described by Mr. E. F. Fincham, who was introduced by the president. He reminded his audience that new plastic substances, especially the acrylic resins, were already being introduced as substitutes for glass before the recent world war and that Mr. Clarkson, working at the East Grinstead Plastic Unit in 1941, was beginning to adopt the technic of mechanical dentistry with a view to improving the appearance of artificial eyes. A large proportion of Mr. Fincham's paper was devoted to the problem of how to achieve close imitation of the iris structure. He contended that color and pattern must not be regarded as qualities isolated from each other.

Dr. Mary Cripps described her experience in the "Treatment of Traumatic and Inflammatory Lesions by Roentgen Radiation and Short Wave Diathermy Combined." Her main conclusion was that these two methods of treatment reenforced each other, so that their beneficial effects were relatively disappointing when one was used apart from the other.

On the afternoon of May 31, 30 cases were presented at a clinical meeting held jointly with the Section of Ophthalmology of the Royal Society of Medicine. Among the patients were a number with war injuries and several prisoners returned from Japanese camps with partial atrophy of the optic nerve. In the absence of Mr. P. H. Adams, the president of the section, the chair during discussion of the cases was taken by the senior vice president, Mr. F. A. Williamson-Noble.

The official guests from abroad were entertained at dinner at the Hall of the Society of Apothecaries in the City of London on the evening of the second day of the congress by the council of the newly formed Faculty of Ophthalmologists. Mr. Frank W. Law, the honorary secretary of the Faculty, had fortunately been able, by virtue of his connection with the Society of Apothecaries, to secure permission for the dinner to be held in these agreeable surroundings, where the guests were received by Sir Stewart Duke-Elder, the president of the Faculty. After dinner, short, informal speeches were made by Sir Stewart Duke-Elder, Miss Ida Mann, Sir John Parsons and all the guests from abroad, beginning with Dr. Arnold Knapp. Unofficial views were exchanged with regard to the possibility of holding an international congress of ophthalmology in 1948.

On June 1, the third and last day of the congress, Dr. D. V. Giri opened the program with a paper on the "Technic of Intracapsular Extraction of Cataracts with Retention of Conjunctival Bridge." He dwelt on the disadvantages of mutilating the iris, arguing that, even if it were true that iridectomy diminished the liability to prolapse—though he doubted that contention—any small advantage in that respect nevertheless was far outweighed by the dangers attending excision of a piece of iris. He also insisted, as did Dr. Arnold Knapp in the Bowman lecture, that depression of the globe increases the liability to loss of vitreous. Dr. Giri also gave detailed consideration to preoperative and postoperative treatment, and his paper was followed by

an interesting discussion, during which Dr. W. H. Melanowski, of Warsaw, spoke in support of the conjunctival bridge.

Next came Dr. W. H. Melanowski's paper on "The More Important Pages in the History of Ophthalmology in Poland." Having deplored the obscuration of Polish culture consequent on language difficulties and political upheavals down the centuries, Dr. Melanowski proceeded to trace the advance of optical and ophthalmic knowledge in Poland from medieval times onward. He referred to the life and work of Vitello, Novicampius, Sirenius, Szokalski, Kamocki, Galezowski and Wicherkiewicz. He reminded members of the society of the link forged by Johnstone between Poland and Scotland and recalled Zieminski's period of study at Moorfields Eye Hospital in 1888. Pictures of the famous Polish ophthalmologists were shown on the screen at the end of Dr. Melanowski's talk, and he then received the warm congratulations of Sir Stewart Duke-Elder.

Dr. C. L. Schepens, of Brussels, contributed a paper entitled "Is Malnutrition the Cause of Tobacco Amblyopia?" He began by saying that tobacco amblyopia was rare in Belgium and Holland before the recent world war but that its incidence was greatly increased during the German occupation. In Dr. Schepens' opinion, this increased incidence was partly due to the inferior quality of the tobacco in general use. During the preparation of high grade tobacco a large proportion of nicotine undergoes oxidation, but this substance is abundant in "green" tobacco, especially in the home-grown kinds. Inferior tobacco did not, however, entirely account for the prevalence of tobacco amblyopia during the war years, for even those who were smoking stores of prewar tobacco displayed an increased susceptibility to the malady. Malnutrition from shortage of protein, fat and vitamins was clearly the other main factor, and in this connection it is worthy of note that the victims all complained of other symptoms besides the visual defect.

Indigestion was invariably present. Cramps, deafness and other disturbances were by no means uncommon. Other features of wartime tobacco amblyopia noted by Dr. Schepens were a lowered average age of incidence, a lower average consumption of tobacco and a higher proportion of changes in the fundus, especially in the younger age groups. He showed numerous charts displaying scotomas near the center of the field but emphasized that the characteristic early change in the fields is a pericecal disturbance. His experience led him to believe that tobacco amblyopia is essentially due to lower capacity of the liver to neutralize toxins and that it is a disease of the retina rather than of the optic nerve, although of course the nerve will undergo consecutive degeneration when the retinal changes have reached an irreversible stage.

Dr. Schepens was warmly congratulated by Mr. H. M. Traquair, who went on to stress the importance of high blood pressure as an etiologic factor in tobacco amblyopia. Mr. Traquair also pointed out that in a predisposed subject an attack of tobacco amblyopia could be precipitated by a fracture, a sharp cold or various other physical disturbances, and even by the onset of mental worry. Dr. H. Gjessing remarked that tobacco amblyopia was common in Norway during the war of 1914 to 1918 when fats were scarce. Sir Stewart Duke-Elder

emphasized the relationship between Dr. Schepens' observations and the experiences reported by the speakers in the discussion on "Ocular Disturbances Associated with Malnutrition." Having commented on the variety of toxins and dietetic defects which might combine to degrade the metabolism of the central nervous system, Sir Stewart expressed the hope that many of the clinical conditions that now seem to be distant may with advancing knowledge be shown to possess a common denominator.

Mr. T. W. Letchworth's paper on "Stereoscopic Vision in Binocular Aphakia" was autobiographic. He recently underwent a successful operation, by Mr. O. G. Morgan, on the left eye for extraction of cataract. Vision in the right eye, the lens of which is opaque is 6/12 with the aid of a small correction, while the left eye obtains 6/6 vision with a correction of + 6.0 D. sph. ⊃ + 4.0 D. cyl., axis 160. Mr. Letchworth emphasized the distortion inevitably produced by the peripheral portion of a strong spectacle lens but claimed that he can readily fuse his right and left images so long as he is looking through the axial portion of his left glass. For work that demands visual precision he uses a contact glass over the left eye but finds it easy to drive a motor car while wearing his ordinary spectacles.

Mr. A. Seymour Philps' paper on "Venous Changes in the Retina in Diabetes" was illustrated by excellent fundus pictures drawn by the author himself. He referred to the propensity of retinal veins in a diabetic subject to split into numerous small twigs, which coalesce farther on. Sacculation, entailed by sudden changes in caliber, was another characteristic feature, and in some instances veins that had undergone prolonged dilatation might be converted into fibrous tissue. Mr. Philps suggested that whereas thrombosis occurs as a result of rapid venous obstruction, slowly progressive obstruction of the veins might offer a reasonable explanation for the changes observed with diabetes. He showed a similar fundus picture of advanced retinal phlebosclerosis in a young man with advanced pulmonary fibrosis and posed the question whether the venous changes in the retina characteristic of diabetes may be due to increased and variable blood pressure. Insulin, of course, entails violent fluctuation in the level of blood pressure. Mr. Philps admitted that his argument was somewhat weakened by the absence of similar venous changes in the fundi of victims of glaucoma, but Mr. Affleck Greeves, in the course of the subsequent discussion, mentioned that he had often observed venous changes in cases of long-standing glaucoma and suggested that thrombosis of the central retinal vein, occurring as a complication of glaucoma and indicative of sudden complete venous blockage, is often preceded by slowly advancing partial obstruction in the retinal veins. Mr. A. J. Ballantyne, whose paper dealing with this subject in the society's *Transactions* for 1943, page 101, had been mentioned by Mr. Philps, attributed the changes to a combination of venous stasis and disease of the vessel walls. He stressed the slow development of diabetic retinopathy, as shown by cases in which punctate hemorrhages may precede exudates by several years. When once the internal limiting membrane has been transgressed, however, rapid changes supervene, leading to retinitis proliferans. Dr. I. C. Michaelson drew attention

to atonia of the capillary system as a factor promoting congestion of the retinal veins in such conditions as diabetes and leukemia.

At next year's congress, Mr. A. J. Ballantyne, the new president of the Ophthalmological Society of the United Kingdom, will be assisted by the normal number of two honorary secretaries, Mr. James Doggart and Mr. E. F. King. Thus, Mr. Frank Law will be relieved of the honorary secretaryship which he has held single handed for the last six congresses. In spite of difficult wartime conditions, there has been no break in the continuity. Although the *Luftwaffe* made a London meeting inadvisable in the spring of 1941, Mr. Law was able to arrange for the congress to be held in Cambridge during September of that year. Then from 1942 onward London was the place of assembly. Mr. Law's untiring efforts were crowned by the success of this, the 1946, congress, which was due in such large measure to his efficient organization.

News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

Army Institute of Pathology and American Registry of Pathology.—What is now known as the Army Institute of Pathology was established in 1863 as the Army Medical Museum. During World War II the activities of the Institute were greatly expanded, especially in the field of diagnostic pathology and research. There are now on file over 170,000 accessions. The results of research at the Institute during the past few years will be published in a volume of about fourteen hundred pages as a part of the official history of World War II. The present director is Col. J. Ash, who will be succeeded on October 1 by Col. Raymond O. Dart.

On request of Major General Norman T. Kirk, the Surgeon General of the Army, the Committee on Pathology of the National Research Council, Division of Medical Sciences, in late 1945 prepared a report on the future development of the Institute. The report has been approved by the Surgeon General and by the War Department.

The essential recommendations in this report are (1) that a new building of adequate size be constructed; (2) that the Institute be organized in four divisions—Department of Pathology, Army Medical Illustration Service, Army Medical Museum and American Registry of Pathology—each headed by a competent specialist; (3) that the staff of the Institute be drawn from both the commissioned ranks of the Army and from the civilian professions; (4) that a comprehensive educational and training program be undertaken; (5) that the vast store of material at the Institute be used for research, and (6) that the services in pathology in the Veterans Hospitals be centralized at the Institute.

The American Registry of Pathology, founded in 1922, thus is, and will continue to be, an integral part of the Army Institute of Pathology. There were, on Jan. 1, 1946, over 43,000 cases registered. To effectuate the new plans as they relate to the Registry, the National Research Council, Division of Medical Sciences, appointed a Committee on the American Registry of Pathology. The members of the Committee are Howard T. Karsner, chairman, Cleveland; Col. J. E. Ash, Washington, D. C.; Brig. Gen. R. Callender, Washington, D. C.; Col. Balduin Lucke, Philadelphia; Robert A. Moore, St. Louis; Benjamin Rones, Washington, D. C.; A. R. Shands Jr., Wilmington, Del., and Henry A. Swanson, Washington, D. C.

At the present time there are fourteen registries as a part of the American Registry of Pathology. These include Registry of Ophthalmic Pathology, established in 1922, sponsored by the American Academy of Ophthalmology and Oto-Laryngology; Lymphatic Tumor Registry, established in 1925, sponsored by the American Association of Pathol-

ogists and Bacteriologists; Bladder Tumor Registry, established in 1927, Kidney Tumor Registry, established in 1940, and Prostatic Tumor Registry, established in 1943, sponsored by the American Urological Association; Registry of Dental and Oral Pathology, established in 1933, sponsored by the American Dental Association; Registry of Otolaryngological Pathology, established in 1935, sponsored by the American Academy of Ophthalmology and Oto-Laryngology; General Tumor Registry, established in 1937, sponsored by the American Society of Clinical Pathologists; Registry of Dermal Pathology, established in 1938, sponsored by the American Academy of Dermatology and Syphilology; Chest Tumor Registry, established in 1942, sponsored by the American Society for Thoracic Surgery; Registry of Neuropathology, established in 1943, sponsored by the American Association of Neuropathologists; Registry of Orthopaedic Pathology, established in 1943, sponsored by the American Academy of Orthopaedic Surgeons; Registry of Veterinary Pathology, established in 1944, sponsored by the American Veterinary Medical Association, and Registry of Gerontology, established in 1945, sponsored by the Gerontological Society, Inc.

Plans for additional registries are under consideration. A professional scientific society wishing to sponsor a registry should communicate with the Director, Army Institute of Pathology, Seventh Street and Independence Avenue, S. W., Washington 25, D. C. The society appoints a committee to work with the Director in supervision of the activities of the Registry, and make an annual contribution to the budget, which is administered by the National Academy of Sciences.

All specimens in the Registry are available for review and research by competent investigators. Sets of slides and accompanying syllabuses on special fields are available for loan to the civilian professions and officers in the federal services. Physicians, dentists and veterinarians are urged to send unusual specimens together with an abstract of the history to the Registry. The contributor receives a report on each specimen and is asked to keep the Registry informed of the follow-up on the patient.

With the reorganization of the Army Institute of Pathology, to be completed during 1946 and 1947, a full time scientific director of the American Registry of Pathology will be appointed, and sufficient clerks and technicians will be available to assure adequate use of the registries for diagnosis, research, training of young men and education of the professions.

American Registry of Pathology.—Many diseases are so rare that any one individual, or even the staff of any one hospital or clinic, has a limited opportunity to study certain conditions and lesions. Conclusions in science must be based on not one but many observations. Therefore, it is desirable to organize and support central agencies for the collection and filing of histories, specimens and follow-up studies.

For over twenty-four years the American Registry of Pathology has been maintained at the Army Institute of Pathology in Washington, D. C. It was founded in 1922 by the then curator of the Army Medical Museum, Brig. Gen. George R. Callender, at the request of the American Academy of Ophthalmology and Oto-Laryngology. Succeeding curators,

Major Paul E. McNabb, Col. Virgil H. Cornell, Col. Raymond O. Dart and Col. J. Earle Ash, have given time and thought to the problems of the Registry. On Jan. 1, 1946, material from over 43,000 cases was on file.

There are now fourteen separate registries, each sponsored by a professional scientific society. Important additions to knowledge have been made by investigations at the Registry, notably on tumors and diseases of the eye, tumors of the lymphatic system and tumors of the bladder.

With the reorganization of the Army Institute of Pathology and with plans for the erection of a new building, sponsored by Major General Norman T. Kirk, the Surgeon General, the American Registry of Pathology takes on increased importance. There will be greater opportunities for the training of specialists, for research and for educational activities.

The American Registry of Pathology deserves support from the civilian professions in terms of contributions of materials by individuals and sponsorship of registries by societies.

Oftalmologicheskiy zhurnal.—A new monthly journal of ophthalmology is being published in the Soviet Union. Heretofore *Vestnik oftalmologii* was the only journal in that country devoted to ophthalmology. In their foreword, the editors (V. Filatov, S. Kalfa and V. Arkhangelsky) state that the journal will be devoted to problems of prevention of blindness. Reconstructive plastic surgery, keratoplasty, and the pathogenesis, diagnosis and treatment of glaucoma and trachoma are some of the other subjects on which leading articles will be published. Space will be devoted to the ophthalmologists from the provinces for the publication of their clinical and theoretic work. A consultation column will be established for them.

The first issue contains the following articles: "Biogenic Stimulators"; "Elastometric Curves in Glaucoma"; "Penicillin in Treatment of Thrombosis of the Cavernous Sinus"; "Tissue Therapy in Contusion Chorioretinitis"; "Tissue Therapy in Ocular Diseases of Hypertensive Origin"; "Electromagnets in Ophthalmic Practice," and "The Fundus in Wounds of the Skull."

The price is 8 rubles.

The Scientific Exhibit, Atlantic City Session of the American Medical Association.—At the Atlantic City Session, June 9 to 13, 1947, the American Medical Association will observe its centennial anniversary. For almost half of those hundred years—since 1899—the Scientific Exhibit has been a feature of each annual session and has developed into a short course in graduate medical instruction.

Exhibits at the 1947 Session will cover all phases of medicine. A certain amount of historical material will be included, but emphasis will be placed on the latest developments of medical science. The Committee on Exhibits of the Section on Ophthalmology consists of Dr. Georgiana D. Theobald, Chairman, 715 Lake Street, Oak Park, Ill.; Dr. Derrick Vail, Chicago, and Dr. A. B. Reese, New York.

Applications for space should be submitted as early as possible, since the closing date is Jan. 13, 1947. Application blanks may be obtained either from the Committee members or from the Director, Scientific Exhibit, American Medical Association, 535 North Dearborn Street, Chicago 10.

Proctor Lecture in Ophthalmology.—The University of California announces the receipt of $20,000, given by Mrs. Francis I. Proctor for the establishment of a lecture in memory of her husband, the late Dr. Francis I. Proctor. The first lecture will be given by Dr. Kenneth Swan, professor of ophthalmology at the University of Oregon Medical School, who will speak on "Contemporary Concepts of Pharmacology and Toxicology of the Cornea." The lecture will be given in Toland Hall of the University of California Medical School in San Francisco on Friday, December 20. This lectureship will be a yearly one.

Research Study Club of Los Angeles.—The sixteenth annual mid-winter post-graduate clinical convention in ophthalmology and otolaryngology, sponsored by the Research Study Club of Los Angeles, will be held Jan. 20 to Jan. 31, 1947. The first week will be devoted to the eye.

The following teachers will take part: Dr. William L. Benedict, Dr. Henry P. Wagener, Dr. Kenneth C. Swan, Dr. David O. Harrington, Dr. Dohrmann K. Pischel and Dr. Meyer Wiener. The fee for the clinical course is $75. Applications should be sent to Dr. Pierre Viole, 1930 Wilshire Boulevard, Los Angeles 5. Owing to the difficulties of obtaining accommodations, it is well to write at once for reservations to Mr. H. M. Nickerson, manager, Elks Club, Douglas MacArthur Park, Los Angeles 5.

The George Washington University Department of Ophthalmology.—The seventh annual W. Thornwall Davis Intensive Post-graduate Course in Ophthalmology will be given the week of Feb. 3 to 8, 1947, at the George Washington University School of Medicine, 1335 H Street, N. W., Washington, D. C., by the resident staff and the following guest lecturers: Dr. F. Heed Adler, Philadelphia; Dr. J. Mason Baird, Atlanta, Ga.; Dr. S. Judd Beach, Portland, Maine; Dr. Hermann M. Burian, Boston; Dr. Ramon Castroviejo, New York; Dr. C. Alvin Clapp, Baltimore; Dr. F. Bruce Fralick, Ann Arbor, Mich.; Dr. Deane B. Judd, Washington, D. C.; Dr. Peter C. Kronfeld, Chicago; Dr. Walter I. Lillie, Philadelphia; Dr. Angus L. MacLean, Baltimore; Mr. Philip L. Salvatori, New York; Dr. Harold G. Scheie, Philadelphia; Dr. Edmund B. Spaeth, Philadelphia, and Dr. Frederick W. Stock, Durham, N. C.

The tenth annual W. Thornwall Davis Post Graduate Course in Ocular Pathology, and Orthoptics and Surgery will be given during the week of Jan. 27 to Feb. 1, 1947. This is a practical course and is limited to 30 registrants.

The secretary, Mary Everist Kramer, Suite 34, 1801 K Street, N. W., Washington 6, D. C., will be glad to furnish on request further details regarding the post-graduate courses in ophthalmology.

Howe Lecture in Ophthalmology.—Prof. William John Brownlow Riddell, fellow of the Royal Faculty of Physicians and Surgeons, and dean of medicine at Glasgow University, gave the Howe lecture in Ophthalmology on "Heredity and Variation in Clinical Ophthalmology" at the Harvard Medical School on Tuesday, Nov. 19, 1946.

SOCIETY NEWS

Washington, D. C., Ophthalmological Society.—The first meeting of the Washington, D. C., Ophthalmological Society for the 1946-1947 season was held on Monday, Nov. 4, 1946, and was a joint session with the Baltimore Ophthalmological Society.

Dr. Richard W. Wilkinson, president of the Washington, D. C., Ophthalmological Society, presided at the meeting. Case presentations of cataracta neurodermatica and vitreous cyst were made by Dr. Edward J. Cummings. Dr. Jules B. Chapman presented a case of cataracta complicata.

The guest speaker of the evening was Prof. W. J. B. Riddell, of the University of Glasgow, Scotland. His presentation was on the "Clinical Valuation of Cataract Operation," and the discussers of this interesting paper were Dr. Clyde A. Clapp, of Baltimore, and Dr. John W. Burke, of Washington, D. C.

A short business meeting followed this discussion, and the meeting was then adjourned until the next session, scheduled for Jan. 6, 1947.

Belgian Society of Ophthalmology.—The Belgian Society of Ophthalmology celebrated its fiftieth anniversary by a meeting in Brussels on Sept. 28 to 30, 1946. The meeting was opened on Saturday, September 28, at 3 p. m., in the presence of Her Majesty, Queen Elisabeth, in the marble hall of the Palais des Academies. The presidential address was given by Professor van der Straeten. A message of the foreign delegations was delivered by Professor van der Hoeve; Dr. Leon Coppez spoke on the scientific work of the society since its foundation, and "The Human Eye in Art" was the subject of an address by Dr. Alaerts.

On Sunday, September 29, the Belgian Society of Ophthalmology met in the Maison des Medecins, 54 boulevard de Waterloo, at 10 o'clock in the morning, with Professor Weekers presiding. The following papers were read: "Blindness of the Newborn," Prof. J. Beauvieux, delegate of the French Society of Ophthalmology; "Ophthalmology in the War Years," Dr. Law, delegate of the Ophthalmological Society of the United Kingdom; "Certain Lesions of the Ciliary Arteries," Professor Zeeman, delegate of the Netherland Society of Ophthalmology; "The Aqueous Humor, That Unknown Quantity," Professor Amsler, delegate of the Swiss Society of Ophthalmology.

At 3 o'clock in the afternoon, with Professor van Canneyt in the chair, the following papers were presented: "Ocular War Injuries from 1939 to 1944," J. Sédan and G. Farnarier (Marseille); "Sympathetic Ophthalmia Cured by Subconjunctival Injections of a Sulfonamide Compound: Report of Three Cases," G. Rénard (Paris); "The Oily Precorneal Layer," E. Wolff (London); "The Technic of Transplantation of Corneal Grafts," G. P. Sourdille (Nantes); "The Vasodilator

Action of Nicotinic Acid on the Blood Vessels of the Retina" (an experimental and clinical article), Henrique Moutinho (Lisbon); "Hypertensive Retinopathy and Hypophysial Diabetes," R. Onfray, Derot and Quentin (Paris); "Retinitis of Septic Origin, Report of Two Cases," R. Lindsay-Rea (London); "Proliferating Retinitis and Cleavage of the Retina," S. Schiff-Wertheimer (Paris); "A Spontaneously Curable Form of Macular Retinal Exudation, Probably Tuberculous," G. Renard (Paris); "A Short Account of Orthoptic Training," M. Pugh (London).

On Monday, September 30, there was an excursion to Antwerp, with a visit to the Rubens house and to the Cathedral, with breakfast at the "Century," in de Keyser Avenue, and in the afternoon a drive was taken in the city, with a visit to the tunnel under the Escaut.

PERSONAL NEWS

Research Project on Onchocerciasis Completed—Dr. William B. Clark, head of the department of ophthalmology, Tulane University of Louisiana School of Medicine, returned to Guatemala on Nov. 7, 1946, where he concluded the research project on onchocerciasis which he began there last year. He returned to New Orleans on Nov. 16, 1946.

Book Reviews

Fourteenth Report of the Memorial Ophthalmic Laboratory, Giza, Cairo, 1939-1944. Ministry of Public Health. Price, 35 piasters. Pp. 140. Cairo, Egypt: Schindler's Press, 1945.

This report covers the period of the war years from 1939 to 1944 and consists of a selection of the more important papers of scientific interest prepared during that time. Owing to excessive costs, all illustrations have been omitted. Reference is made to seventeen other papers by members of the staff, not included in the report but all appearing in issues of the *Bulletin of the Ophthalmological Society of Egypt*. Case reports of special clinical and pathologic interest, which were a prominent feature of previous (annual) reports of this laboratory, are also omitted.

Twelve papers are given. The first, by the director, Rowland P. Wilson, is entitled, "Trachoma: A Selection of Personal Observations and Experiences." It reports the author's observations on the disease over an eighteen year period. Under the heading of etiology are comments on the early studies on Bacterium (Noguchia) granulosis and the reasons which led to its elimination as an etiologic possibility. The author then mentions the steps which led him to conclude that trachoma is a virus disease, in which the inclusion bodies of Halberstädter and Prowazek are the intracellular colonies of the virus. Under the head of epidemiology he notes that in Egypt trachoma is pandemic, affecting as high as 100 per cent of village populations. He notes that many factors, in particular the acute ophthalmias, are concerned in the spread of the disease but that the observance of simple personal hygienic principles would be sufficient to prevent its spread in most cases. Wilson does not believe that there is any special racial susceptibility, although he notes that the tendency to spontaneous cure is more evident among Egyptians than among Europeans. He then describes his observations in cases of incipient trachoma and stresses the fact that the virus infects the limbal epithelium at the same time that it infects the palpebral conjunctiva. He concludes with observations on the pathologic character of follicles, on differential diagnosis, on prophylaxis and on sulfonamide therapy.

In a second paper, Wilson discusses the economic importance of the acute ophthalmias and makes recommendations for their control. He includes statistics on the incidence of the ophthalmias in the various age groups and their effect on visual acuity. It is estimated that at least 75 per cent of the blindness in Egypt is produced by the acute ophthalmias, with approximately 120,000 Egyptians blind in both eyes from this cause. Wilson believes that there is every reason to hope that sulfonamide therapy alone can prevent entirely the serious sequelae of these diseases, as well as reduce indirectly the incidence of trachoma.

In a third paper, Wilson and Bland present bacteriologic and clinical observations on treatment of the acute ophthalmias with the sulfonamide

compounds and with penicillin. They conclude that the sulfonamide drugs are of much greater value than penicillin, particularly in the treatment of Koch-Weeks conjunctivitis.

This paper is followed by one by Bland on spontaneous folliculosis of the conjunctiva in grivet and vervet monkeys, with observations on the susceptibility of the grivet to the trachoma virus. Bland concludes that the reaction of grivets and vervets to trachoma cannot be distinguished histologically or clinically from spontaneous folliculosis and that these animals are therefore unsuitable for research on trachoma. He notes, however, that the trachoma virus still produced trachoma in a human volunteer after four passages in the grivet; inclusion bodies, present in the original inoculum, could not be found in the grivet but reappeared in the case of experimentally produced human trachoma.

In an important article, entitled "The Etiology of Trachoma: A Critical Review of Present Knowledge," Bland concludes that the trachoma virus bears a close relationship to the viruses of inclusion conjunctivitis, lymphogranuloma venereum and psittacosis. He further concludes that these viruses stand in an intermediate position between the rickettsias and the large viruses. He prefers to call them "basophilic viruses," on account of the blue staining of their initial bodies.

The volume concludes with five short reports by other members of the laboratory staff. El-Tobgy describes a scheme for massive abortive treatment of the acute ophthalmias with chemotherapy and recommends sulfapyridine, sulfadiazine or sulfathiazole, given in a daily dose of 0.5 Gm. for each 20 Kg. of body weight over a four day period. Kamel reports on schistosomiasis (bilharziasis) of the conjunctiva and notes that up to 1936 only 3 cases of the ocular disease had been seen in the laboratory. Since then, however, he has seen an additional 5 cases. He notes that the lesions are not painful and that the patient's attention is attracted to them only by reason of the disfigurement they cause. Kamel reports on clinical and histopathologic observations in 3 cases of leishmaniasis involving the eyelids. He notes that roentgen therapy and diathermy have been most efficacious. Nashed reports on chemotherapy of the acute ophthalmias and concludes that oral treatment is more successful than local application. Along similar lines, Hilmi Hamed describes results of experiments in the treatment of Koch-Weeks and gonococcic conjunctivitis and sulfapyridine. He recommends a combination of intramuscular injections and oral therapy.

The director notes that the scientific work of the laboratory was in large part interrupted by the war. The twelve papers included in the fourteenth report, however, contain much of value, and the more significant ones will be abstracted separately.

PHILLIPS THYGESON.

Studies from the George Washington University School of Medicine, 1943-1944. Washington, D. C., 1944.

Among the forty-eight reprints there are two on the eye: "Military Ophthalmology," by W. T. Davis, and "Leiomyoma of the Iris," by W. T. Davis, E. Sheppard and W. J. Romejko. Both these articles were published in the *American Journal of Ophthalmology* and have been reviewed.

ARNOLD KNAPP.

Clinical Ophthalmoscopy. By Arthur J. Bedell, M.D., F.A.C.S., D. Sc.,LL.D. Two hundred glass-mounted Kodachrome 2 by 2 inch reproductions with concise history and description of each. Price, $100. James A. Glenn, 76 Columbia St., Albany N. Y. 1946.

Since the publication of Jaeger's "Atlas," in 1855, the illustration of lesions of the fundus has engaged the attention of many ophthalmologists. In England, Frost's "Atlas" appeared in 1896, and there were many beautiful illustrations in the *Transactions of the Ophthalmological Society of the United Kingdom* which were also the work of that eminent artist, A. W. Head. Oeller's "Atlas," in 1896, was the first atlas in which the reproductions were made in oils, and they were painted by the author. A beautiful atlas in color was published by di Marzio in 1937, in Italy.

The era of fundus photography was initiated with Dimmer's painstaking work, which began in 1905 and was summarized in an atlas by Dimmer and Pillat in 1927; but photographic reproduction did not come into its own until the Zeiss works brought out the Nordenson camera, based on modern optical principles (Gullstrand), with which excellent photographs were taken and the procedure came into general use. Tillé et Couadau's "Atlas" appeared in France in 1939, and Bedell published his "Atlas on Fundus Photographs" in 1939. Photographs in color could not be taken on account of the necessarily long exposure, but with the manufacture of the more sensitive films of the present day this difficulty was surmounted and splendid photographs in color are now in general use. Dr. Bedell is a pioneer in photography of the fundus, and his beautiful pictures in colors have illustrated many papers and enlivened many medical meetings. He has now brought out the first kodachrome atlas of fundus pictures. In a series of 200 glass-mounted Kodachrome, 2 by 2 inch (5 by 5 cm.) reproductions, the subject of ophthalmoscopy is systematically covered. A small accompanying manual brings a concise history and gives a description of each picture. The series begin with the normal fundus and its congenital anomalies; then come circulatory disturbances associated with hypertension and arteriosclerosis, lesions of the blood vessels, diabetes, senile macular degeneration, retinochoroiditis, tumors of the choroid, angiomatosis retinae, retinitis pigmentosa, angioid streaks, changes of the optic nerve, glaucoma, traumatic lesions and intraocular foreign bodies. The color, the details and the depth perception are as true to life as the image with the ophthalmoscope at its best. The much sought after colored photographic reproduction has finally been obtained, and Dr. Bedell can be proud of his success in the difficult mastery of the intricate subject of fundus color photography. These pictures are by far the best that have been published, and it is a pleasure to study them and to enjoy their beauty. At last a collection of transparencies has been made available for teaching ophthalmoscopy, and the student can now see and study the fundus picture without reflexes in all its true and beautiful colors.

This collection of kodachromes comes in two secure metal boxes and at a very reasonable price; there are empty places for 100 additional slides, which it is to be hoped that Dr. Bedell will gradually fill with additional beautiful photographs in the years to come.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London, England.

Pan-American Congress of Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretaries: Dr. Conrad Berens, 35 E. 70th St., New York. Dr. M. E. Alvaro, 1511 Rua Consolacão, São Paulo, Brazil.
Place: Habana, Cuba. Time: February 1948.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chengtu Ophthalmological Society

President: Dr. Eugene Chan.
Secretary: Dr. D. S. Shen, Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.
Place: Eye, Ear, Nose and Throat Hospital, Chengtu, Szechuan, China.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 22ł Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

Faculty of Ophthalmologists

President: Brig. Sir Stewart Duke-Elder, 63 Harley St., London, W. 1, England.
Secretary: Mr. Frank W. Law, 45 Lincoln's Inn Fields, London, W. C. 2, England.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. I. Imre, Budapest.
Assistant Secretary: Dr. Stephen de Grósz, University Eye Hospital, Máriautca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

North of England Ophthalmological Society

President: Mr. E. F. Wilson, 24 Upper Northgate St., Chester.
Secretary: Mr. William M. Muirhead, 70 Upper Hanover St., Sheffield 3.
Place: Manchester, Leeds, Newcastle-upon-Tyne, Liverpool, Sheffield and Bradford, in rotation. Time: October to May.

Ophthalmological Society of Australia

President: Dr. J. Ringland Anderson, Astor House, 108 Collins St., Melbourne, Victoria.
Secretary: Dr. D. A. Williams, 27 Commonwealth St., Sydney.

Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the secretary, Dr. Mohammed Khalil.

Ophthalmological Society of Hospital de Nuestra Señora de la Luz

Chairman: Dr. Manuel J. Icaza y Dublán, México, D. F., Mexico.
Secretary: Dr. Jorge Meyrán, México, D. F., Mexico.

Ophthalmological Society of South Africa

President: Dr. A. W. Sichel, National Mutual Bldg., Church Square, Cape Town.
Secretary: Dr. J. K. de Kock, Groote Kerk Bldg., 32 Parliament St., Cape Town.

Ophthalmological Society of the United Kingdom

President: Mr. Charles B. Goulden, 89 Harley St., London.
Secretary: Mr. Frank W. Law, 30 Devonshire Pl., London, W. 1.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Oxford Ophthalmological Congress

Master: Mr. F. A. Williamson-Noble, 27 Harley St., London, W. 1, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 3-5, 1947.

Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

Philippine Ophthalmological and Otolaryngological Society

President: Dr. Antonio S. Fernando, Philippine General Hospital, Manila.
Secretary-Treasurer: Dr. José N. Cruz, Philippine General Hospital, Manila.

Polish Ophthalmological Society

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

Puerto Rico Medical Association, Section of Ophthalmology and Otolaryngology

President: Dr. José T. Picó, Avenida Ponce de Leon 15, San Juan 10.
Secretary: Dr. Ricardo F. Fernández, Avenida Ponce de Leon 15, San Juan 10.

Revista Brasileira de Oftalmologia

President: Dr. Caldas Britto, Largo de Carioca 5-6° andar, Rio de Janeiro, Brazil.
Secretary: Dr. Evaldo Campos, R. Rodrigo Silva 7-1° andar, Rio de Janeiro, Brazil.
Place: Rio de Janeiro, Brazil. Time: Third Friday of every month from April to December.

Royal Society of Medicine, Section of Ophthalmology

President: Col. F. A. Juler, 96 Harley St., London, W. 1, England.
Secretary: Dr. Harold Ridley, 60 Queen Anne St., London, W. 1, England.

São Paulo Society of Ophthalmology

President: Dr. Armando Gallo, Rua Benjamin Constant, 67, 9° Andar São Paulo, Brazil.
Secretary: Dr. F. Amédée Féret Filho, Rua Marconi, 48, 4° Andar, São Paulo, Brazil.

Scottish Ophthalmological Club

President: Dr. S. Spence Meighan, 13 Woodside Pl., Glasgow, C. 3.
Secretary: Dr. Alexander Garrow, 15 Woodside Pl., Glasgow, C. 3.
Place: Edinburgh and Glasgow, in rotation.

Sociedad Argentina de Oftalmologia

Chairman: Dr. Jorge Malbrán, Buenos Aires.
Secretary: Dr. Benito Just Tiscornia, Santa Fe 1171, Buenos Aires.

Sociedad Cubana de Oftalmologia

President: Prof. Lorenzo Comas, Calle D #461, Vedado, Habana, Cuba.
Secretary: Dr. Oscar F. Horstmann, Calle 5ta. #702, Vedado, Habana, Cuba.
Time: Second Tuesday of every month.

Sociedad Oftalmologia del Litoral, Rosario (Argentina)

President: Prof. Dr. Carlos Weskamp, Laprida 1159, Rosario.
Secretary: Dr. Arturo Etchemendigaray, Villa Constitución, Santa Fé.
Place: Rosario. Time: Last Saturday of every month, April to November. All correspondence should be addressed to the President.

Sociedade de Oftalmología del Norte

President: Dr. Alberto Cárdenas.
Secretary: Dr. Jorge Luis Castillo, Mendoza 421, Tucumán, Argentina.

Sociedade de Oftalmologia de Minas Gerais

President: Prof. Hilton Rocha, Rua Rio de Janeiro 2251, Bello Horizonte, Minas Geraes, Brazil.
Secretary: Dr. Ennio Coscarelli, Rua Aimorés 1697, Bello Horizonte, Minas Geraes, Brazil.

Sociedade de Oftalmologia e Otorrinolaringologia de Rio Grande do Sul

President: Dr. Luiz Assumpção Osorio, Edificio Vera Cruz, Apartamento 134, Porto Alegre, Rio Grande do Sul.
Secretary: Dr. Fernando Voges Alves, Caixa Postal 928, Porto Alegre, Rio Grande do Sul.

Sociedade de Ophthalmologia e Oto-Rhino-Laryngologia da Bahia

President: Dr. Theonilo Amorim, Barra Avenida, Bahia, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

Società Oftalmologica Italiana

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

Secretary: Dr. K. O. Granström, Södermalmstorg 4, Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Derrick Vail, 55 E. Washington St., Chicago.
Secretary: Dr. R. J. Masters, 23 E. Ohio St., Indianapolis.
Place: Atlantic City. Time: June 9-13, 1947.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Alan C. Woods, Johns Hopkins Hospital, Baltimore 5.
President-Elect: Dr. C. H. McCaskey, 20 N. Meridian St., Indianapolis, Ind.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100–1st Ave. Bldg., Rochester, Minn.
Place: Palmer House, Chicago. Time: Oct. 12-17, 1947.

American Ophthalmological Society

President: Dr. John W. Burke, 1740 M St. W., Washington, D. C.
Secretary-Treasurer: Dr. Walter S. Atkinson, 129 Clinton St., Watertown, N. Y.

ASSOCIATION FOR RESEARCH IN OPHTHALMOLOGY, INC.

Chairman: Dr. Derrick Vail, 55 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Brittain F. Payne, 17 E. 72d St., New York.
Assistant Secretary-Treasurer: Dr. Hunter Romaine, 35 E. 70th St., New York.

CANADIAN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto 5.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto 5.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. J. A. MacMillan, 1410 Stanley St., Montreal.
Secretary-Treasurer: Dr. Kenneth B. Johnston, Suite 1, 1509 Sherbrooke St. W., Montreal.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. Mason H. Bigelow, 1790 Broadway, New York.
Secretary: Miss Regina E. Schneider, 1790 Broadway, New York.
Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Anthony Ambrose, 31 Lincoln Park, Newark.
Secretary: Dr. William F Keim Jr., 15 Washington St., Newark 2.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

CENTRAL ILLINOIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Stuart Broadwell, 101½ N. 5th St., Springfield, Ill.
Secretary-Treasurer: Dr. William F. Hubble, 861-867 Citizens Bldg., Decatur, Ill.

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. P. G. Spelbring, 131 S. Barstow St., Eau Claire.
Secretary: Dr. G. L. McCormick, 650 S. Central Ave., Marshfield.

HAWAII EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. F. J. Pinkerton, 7 Young Hotel Bldg., Honolulu.
Secretary-Treasurer: Dr. L. Q. Pang, 52 S. Vineyard St., Honolulu 39.
Place: Honolulu. Time: Third Thursday of each month.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Howard F. Hill, 177 Main St., Waterville, Maine.
Secretary-Treasurer: Dr. Merrill J. King, 264 Beacon St., Boston 16.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. D. H. O'Rourke, 1612 Tremont Pl., Denver.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Julius A. Weber, 640 Stimson Bldg., Seattle 1, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 301 Stimson Bldg., Seattle 1, Wash.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Sheldon Clark, Sterling, Ill.
Secretary-Treasurer: Dr. Harry R. Warner, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. A. R. McKinney, 330 S. Washington St., Saginaw, Mich.
Secretary-Treasurer: Dr. Harold H. Heuser, 207 Davidson Bldg., Bay City, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July, August and September.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. C. Decker, 515 Francis Bldg., Sioux City, Iowa.
Secretary-Treasurer: Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Savage Zerfoss, 165–8th Ave. N., Nashville 3, Tenn.
Secretary: Dr. Alston Callahan, 908 S. 20th St., Birmingham 5, Ala.
Place: Miami, Florida. Time: Nov. 6, 1946.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: Dr. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. V. Foster, State College.
Secretary-Treasurer: Dr. J. McClure Tyson, Deposit National Bank Bldg., Dubois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. E. C. Moulton, 619 Garrison Ave., Fort Smith.
Secretary: Dr. K. W. Cosgrove, 7 Urquhart Bldg., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. George H. Stine, 23 E. Pikes Peak Ave., Colorado Springs.
Secretary: Dr. J. Leonard Swigert, 320 Republic Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Paul B. MacCready, 442 Temple St., New Haven.
Secretary-Treasurer: Dr. W. H. Turnley, 1 Atlantic St., Stamford, Conn.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. William O. Martin Jr., Doctors Bldg., Atlanta.
Secretary-Treasurer: Dr. C. K. McLaughlin, 666 Cherry St., Macon.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. W. E. Stewart, 721 Wabash Ave., Terre Haute.
Secretary: Dr. Russell A. Sage, 23 E. Ohio St., Indianapolis.
Place: French Lick. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. C. S. O'Brien, University Hospital, Iowa City.
Secretary-Treasurer: Dr. Carl A. Noe, 120–3d Ave. S. E., Cedar Rapids.

KANSAS STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. B. Granger, Emporia.
Secretary: Dr. George F. Gsell, 911 Beacon Bldg., Wichita 2.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. George S. Adkins, 121 N. President St., Jackson, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

MEDICAL SOCIETY OF THE STATE OF PENNSYLVANIA, SECTION ON EYE, EAR, NOSE AND THROAT DISEASES

Chairman: Dr. William T. Hunt Jr., 1205 Spruce St., Philadelphia 7.
Secretary: Dr. Gabriel Tucker, 250 S. 18th St., Philadelphia 3.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Edmond L. Cooper, 1553 Woodward Ave., Detroit 26.
Secretary: Dr. Ralph H. Gilbert, 110 Fulton St. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Karl C. Wold, 1051 Lowry Bldg., St. Paul 2.
Secretary: Dr. William A. Kennedy, 372 St. Peter St., St. Paul 2.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. H. Casebeer, 44 W. Park Ave., Butte.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

NEBRASKA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. C. W. Buvinger, 50 Washington St., East Orange.
Secretary: Dr. Z. Laurence Griesemer, 1145 E. Jersey St., Elizabeth.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Maxwell D. Ryan, 660 Madison Ave., New York 21.
Secretary: Dr. Thomas H. Johnson, 30 W. 59th St., New York.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. A. J. Ellington, 412 S. Spring St., Burlington.
Secretary: Dr. J. A. Harrill, Bowman Gray School of Medicine, Winston-Salem.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. D. Perrin, 221–5th St., Bismarck.
Secretary-Treasurer: Dr. M. T. Lampert, Minot.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Wilfred Belnap, 833 S. W. 11th Ave., Portland.
Secretary-Treasurer: Dr. C. W. Kuhn, 1020 S. W. Taylor St., Portland 5.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

PENNSYLVANIA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Thomas F. Furlong Jr., 36 Parking Plaza, Ardmore.
Secretary: Dr. Benjamin F. Souders, 143 N. 6th St., Reading.
Time: Last week in April.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society, Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. H. Stokes, 125 W. Cheves St., Florence.
Secretary-Treasurer: Dr. Roderick Macdonald, 330 E. Main St., Rock Hill.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Burchfield, Maryville.
Secretary-Treasurer: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. F. H. Rosebrough, 603 Navarro St., San Antonio.
Secretary: Dr. M. K. McCullough, 1717 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. E. B. Fairbanks, 315 Medical Arts Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Dean Spear, 516 Boston Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Thomas E. Hughes, 1000 W. Grace St., Richmond.
Secretary-Treasurer: Dr. Francis H. McGovern, 105 S. Union St., Danville.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. L. Mather, 39 S. Main St., Akron, Ohio.
Secretary-Treasurer: Dr. V. C. Malloy, 2d National Bank Bldg., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. B. M. Cline, 153 Peachtree St. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 815 Doctors Bldg., Atlanta, Ga.
Place: Academy of Medicine. Time: 7:30 p. m., fourth Monday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Jonas Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Fred Reese, 330 N. Charles St., Baltimore 1.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. W. Chunn Parsons, 425 Woodward Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. Benjamin C. Rosenthal, 140 New York Ave., Brooklyn.
Secretary-Treasurer: Dr. Louis Freimark, 256 Rochester Ave., Brooklyn 13.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. William M. Howard, 389 Linwood Ave., Buffalo 9.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo 9.
Time: Second Thursday of each month from October to May.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Providence Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. W. A. Mann, 30 N. Michigan Ave., Chicago 2.
Secretary: Dr. J. R. Fitzgerald, 3215 W. North Ave., Chicago.
Place: Continental Hotel, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Dr. D. T. Vail, 441 Vine St., Cincinnati.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. M. Paul Motto, Rose Bldg., Cleveland.
Secretary: Dr. H. H. Wygand, 624 Guardian Bldg., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Burton Chance, 317 S. 15th St., Philadelphia.
Clerk: Dr. George F. J. Kelly, 37 S. 20th St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. M. Goldberg, 328 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. J. Miller, 21 E. State St., Columbus, Ohio.
Place: University Club. Time: 6:15 p. m., first Monday of each month, from October to May, inclusive.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. L. W. O. Janssen, 710 Medical Professional Bldg., Corpus Christi, Texas.
Secretary: Dr. F. B. Kelly, 519 Medical Professional Bldg., Corpus Christi, Texas.
Time: 6:30 p. m., third Tuesday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Speight Jenkins, 1719 Pacific Ave., Dallas, Texas.
Secretary: Dr. L. Darrough, Dallas Medical and Surgical Clinics, Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. I. McPherrin, 406–6th Ave., Des Moines, Iowa.
Secretary-Treasurer: Dr. C. C. Jones, Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., fourth Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Wesley G. Reid, 974 Fisher Bldg., Detroit 2.
Place: Club rooms of Wayne County Medical Society. Time: First Monday of each month, November to April, inclusive.

Detroit Ophthalmological Society

President: Dr. Bruce Fralick, 201 S. Main St., Ann Arbor, Mich.
Secretary: Dr. William S. Gonne, 619 David Whitney Bldg., Detroit 26.
Place: Club rooms of Wayne County Medical Society. Time: 6:30 p. m., third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. Frank C. Furlong, 713 Union St., Schenectady.
Secretary-Treasurer: Dr. E. Martin Freund, 762 Madison Ave., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. C. R. Lees, 602 W. 10th St., Fort Worth 2, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1305 Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. J. Matt Robison, 1304 Walker Ave., Houston, Texas.
Secretary: Dr. John H. Barrett, 1304 Walker Ave., Houston, Texas.
Place: River Oaks Country Club. Time: 6:30 p. m., second Thursday of each month from October to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. J. Jerome Littell, 603 Hume Mansur Bldg., Indianapolis.
Secretary: Dr. J. Lawrence Sims, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Edgar Johnson, 906 Grand Ave., Kansas City, Mo.
Secretary: Dr. W. E. Keith, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Robert G. Thornburgh, 117 E. 8th St., Long Beach 2, Calif.
Secretary-Treasurer: Dr. Kirt Parks, 605 Professional Bldg., Long Beach 2, Calif.
Place: Seaside Hospital. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. A. R. Robbins, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. K. C. Brandenburg, 110 Pine Ave., Long Beach 2, Calif.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE AND EAR SOCIETY

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

LOWER ANTHRACITE EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Secretary: Dr. Frazier Williams, 1801 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Frank G. Treskow, 411 E. Mason St., Milwaukee 2.
Place: University Club. Time: 6:30 p. m., fourth Tuesday of each month from October to May.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. L. F. Badeaux, 502 Cherrier St., Montreal, Canada.
Secretary: Dr. John V. V. Nicholls, 1414 Drummond St., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. M. M. Cullom, 700 Church St., Nashville, Tenn.
Secretary: Dr. R. E. Sullivan, 432 Doctors Bldg., Nashville 3, Tenn.
Place: James Robertson Hotel. Time: 6:30 p. m., third Monday of each month from October to May.

New Orleans Ophthalmological and Otolaryngological Society

President Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, 1018 Maison Blanche Bldg. New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to May.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Brittain F. Payne, 17 E. 72d St., New York 21.
Secretary: Dr. Milton Berliner, 57 W. 57th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Benjamin Friedman, 6 W. 77th St., New York.
Secretary: Dr. Benjamin Esterman, 983 Park Ave., New York 28.
Place: New York Academy of Medicine, 2 E. 103d St. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Oklahoma City Academy of Ophthalmology and Otolaryngology

President: Dr. S. R. Shaver, 117 N. Broadway, Oklahoma City.
Secretary: Dr. William Mussil, Medical Arts Bldg., Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. A. A. Steinberg, 1502 Farnam St., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha 2.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m. program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. Thomas Sanfacon, 340 Park Ave., Paterson, N. J.
Secretary-Treasurer: Dr. J. Averbach, 435 Clifton Ave., Clifton, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

President: Dr. L. Waller Winckler, Philadelphia.
Secretary: Dr. Robert T. M. Donnelly, 255 S. 17th St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Jay G. Linn, Jenkins Arcade, Pittsburgh.
Secretary: Dr. Robert J. Billings, Jenkins Arcade, Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

READING EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Claude W. Bankes, 212 N. 6th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading, Pa.
Place: Wyomissing Club. Time: 6:30 p. m., third Wednesday of each month from September to July.

RICHMOND EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Luther C. Brawner, Professional Bldg., Richmond, Va.
Secretary: Dr. Clifford A. Folkes, Professional Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. A. Lange, 3903a Olive St., St. Louis.
Secretary: Dr. William Kleinberg, Frisco Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Fourth Friday of each month from October to April, inclusive, except December, at 8:00 p. m.

SAN ANTONIO OPHTHALMO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. James P. Aderhold, Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Virgil S. Steele, South Texas Bldg., San Antonio, Texas.
Place: San Antonio Texas, and Brooke General Hospital. Time: 7 p. m., second Tuesday of each month from September to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. C. B. Cowan, 490 Post St., San Francisco.
Secretary: Dr. D. Harrington, 384 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Robert L. Pohl, W. 1104, 21st Ave., Spokane, Wash.
Secretary: Dr. Malcolm N. Wilmes, 407 Riverside Ave., Spokane, Wash.
Place: Spokane Medical Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. A. H. Rubenstein, 713 E. Genesee St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. H. Blaisdell, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. W. W. Randolph, 1838 Parkwood Ave., Toledo 2, Ohio.
Secretary: Dr. John L. Roberts, 316 Michigan St., Toledo, Ohio.
Place: Toledo Club. Time: Each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. R. G. C. Kelly, 14 Lynwood Ave., Toronto 5, Canada.
Secretary: Dr. Alfred J. Elliot, 802 Medical Arts Bldg., Toronto 5, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. Harold M. Downey, 1740 M St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Richard W. Wilkinson, 1408 L St. N. W., Washington, D. C.
Place: Medical Society of District of Columbia Bldg., 1718 M St. N. W., Washington, D. C. Time: 7:30 p. m., first Monday in November, January, March and May.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.

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